F-Series AC Servodrives, Power Supplies, & Servomotors

Installation & Operation Manual
SAC-F01f

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February 19, 1997

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Chapter 1
Welcome

1 Welcome

This manual provides information about ORMEC's F-Series AC Brushless Servodrives and Power Supplies---providing both a technical description and information required for their installation, operation and maintenance.

The manual is divided into the following chapters:

Chapter 1	**Welcome** introduces you to this manual and how it is organized.
Chapter 2	**General Description** gives an overview of the F-Series product family.
Chapter 3	**Installation** provides instructions on how to install your Power Supply and Servodrive units. It also provides a complete hardware description of the F-Series Power Supplies and Servodrives, including detailed information on each unit's interface.
Chapter 4	**Operation** documents the power up and initial configuration approach for the F-Series.
Chapter 5	**Getting Started** provides detailed instructions on how to run your F-Series system for the first time.
Chapter 6	**Specifications** provides a detailed list of Power Supply, and Servodrive and compatible F-Series brushless Servomotor performance specifications.
Chapter 7	**Maintenance and Troubleshooting** documents the various status and alarm indicators.
Appendixes	**Appendixes** contain a detailed drawing set.

Chapter 2
General Description

2 General Description

This manual covers the F-Series Power Supplies and AC Servodrives, which operate with ORMEC's motion controllers and control the MAC-F Series AC Servomotors. These Power Supplies, AC Servodrives, and their corresponding motors provide the following capabilities and features:

2.1 Power Supply Capabilities and Features

- **Multiple Servodrive Operation:** One F-Series Power Supply can power up to 7 F-Series Servodrives (depending on the size of the Power Supply and Servodrives).
- **Standard Line Voltage Input:** F-Series Power Supplies can be operated directly on commercial power lines which supply 230 VAC for the main power, and 115 VAC for the control power.
- **Shunt Regulator:** All F-Series Power Supply models have a built-in shunt regulator on the bus power supply to handle regenerative load conditions. The regenerative discharge resistors are either internal or external to the Power Supply depending on the model.
- **Bus Voltage Fault Detection and Protection:** Detection and protection against low bus voltage, high bus voltage (PAC-F12, F20 & F20R only), shunt regulator overload (PAC-F12, F20 & F20R only), and over temperature (PAC-F50R and F75R only) are provided.
- **Diagnostics:** Diagnostic status and fault indications are provided by multiple LEDs on the front of the Power Supply.
- **Fault Relay Output:** A relay contact, which is open during a Power Supply fault, is available for use in an emergency stop interlock circuit.
- **Soft Start:** Circuitry is provided to help reduce Power Supply in-rush current.
- **UL Listed**

2.2 Servodrive Capabilities and Features

- **Wide Power Range:** Output power ratings range from 1.1 KVA to 20.0 KVA.
- **Torque Mode Operation:** When combined with DSP based velocity and position loops in ORMEC motion controllers, torque mode operation eliminates the need for user adjustable potentiometers and allows extremely high load inertia to motor inertia ratios.
- **Wide Current Loop Bandwidth:** For high positioning accuracy and response.
- **Velocity Monitor:** A high quality velocity monitor signal is derived from the position transducer and provided for testing and analog velocity loop closure (distributed feedback applications).
- **Torque Monitor:** A calibrated torque monitor signal simplifies system test.
- **UL Listed**

Modular Servodrive Construction

- **Safety:** The separate "control power" supply input is distinct from the "main power" used for electromotive power. This provides superior safety and diagnostic features. Separate control power for fault-detection and diagnostics allows the main power to be removed whenever a fault condition is detected, while maintaining the status indicator LEDs and output signals for troubleshooting.
- **Small Package:** The F-Series Servodrives have narrow "footprints" to conserve panel space.

Fault Detection and Diagnostics

- **Fault Detection and Protection:** Fault detection and protection features include high and low bus voltage, current output fault, RMS current limit fault, Servodrive over temperature, motor overspeed and loss of feedback.
- **Diagnostics:** Diagnostic status and fault indications are provided by the nine LEDs on the front of the Servodrive.

Optically Coupled Safety Interlocks

- **Torque Enable Input:** The fail-safe Torque Enable input requires the motion control electronics to actively sink current in order to enable motor output torque.
- **No Alarm Output:** The No Alarm output is normally ON (Sinking current) and turns OFF whenever a fault is detected. Fail-Safe interlocking is provided when this output is attached to a Fail-Safe input of the control electronics, as it is with all ORMEC motion controllers.
- **Alarm/Status Outputs:** Three alarm/status outputs are provided to indicate over temperature/RMS current limit fault, current output fault, and high bus voltage conditions.

- **Remote Alarm Reset:** A remote alarm reset allows the ORMEC motion controller to reset most Servodrive faults without the need to cycle control power.

2.3 Servomotor Capabilities and Features

- **Wide Power Range:** Output motor power ratings ranges from 0.31 to 20.5 HP.
- **Wide Torque Range:** Continuous stall torque's range from 7 to 960 in-lb (0.84 to 109 N-m).
- **High Speed:** Maximum motor speeds range from 1,500 to 7,500 RPM.
- **High Torque-to-Inertia Ratios:** Motors with high *Torque-to-Inertia* ratios deliver a higher percentage of rated power to the load in applications which require high acceleration and deceleration rates.
- **Durable Construction:** Service life is maximized by the brushless motor construction, high thermal efficiency frame and rugged sealed bearings.
- **Industrial Resolver:** The rugged internal resolver measures up to 16,384 precise increments of position, or counts, per revolution.
- **Low Torque Ripple:** Sinusoidal construction combined with precise electronic commutation provide low motor output torque ripple.
- **Harsh Environment Operation:** Standard IP65 motor sealing with optional IP67 sealing permits operation in harsh industrial environments.
- **UL Recognized** (except for Washdown motors)

Other Available Options[1]

- **Fail-Safe Brake:** An optional Fail-Safe brake is available integral to the motor.
- **External Encoder Mounting:** The external encoder mounting option is available for applications requiring the use of a high resolution encoder.
- **Several Housing Options:** Several housing options are available including: explosion proof and washdown rated (FDA guideline compliant) motor housings.

[1] Contact your ORMEC Sales and Applications Engineer for further information regarding available F-Series options.

Chapter 3
Installation

3 Installation

3.1 Connection Diagram

A Connection Diagram for a typical F-Series system is shown in Appendix A. The connections to the Servodrive and Power Supply are also described in the next few sections. **BEFORE APPLYING POWER, REFER TO THE TEST RUN SECTION OF THE "GETTING STARTED" CHAPTER.**

NOTE: **Install all Power Supply, Servodrive, and Servomotor power wiring (including ground wiring) according to NEC (National Electric Code) or UL (Underwriters Laboratories) specifications and in compliance with local ordinances.**

WARNING: **F-Series Power Supplies, Servodrives and Servomotors are high voltage equipment, using 230 VAC input power and a 325 VDC main DC Bus.**

3.2 Receiving and Inspection

ORMEC Power Supplies, Servodrives, Servomotors, and their associated accessories are put through rigorous tests at the factory before shipment. After unpacking, however, check for damage which may have been sustained in transit. The bolts and screws should all be tight, and motor output shafts should rotate freely by hand. Check the Power Supplies, Servodrives, and any accessories for bent or broken components or any other physical damage before installation.

3.3 Power Supply and Servodrive Panel Mounting and Environment

Panel mounting data is available in the Specifications Section and **Appendix B**. The Power Supply and Servodrive environment should be maintained as follows:

- Ambient operating temperature should be between 0 and 45°C (derated performance available up to 55°C, refer to the Power Supply and Servodrive Output Specifications sections for further information).
- If the electrical panel is subjected to vibration, mount the units on shock absorbing material.
- Avoid use in corrosive atmospheres which may cause damage over time.
- Select a location with minimum exposure to oil, water, hot air, high humidity, excessive dust, or metallic particles.
- The proper mounting orientation for the Power Supplies and Servodrives is vertical on a panel using the mounting holes (4) on the base plate.
- Servodrives can be mounted on either side of the Power Supply, however, no more than 4 Servodrives can be mounted on one side of a Power Supply. Servodrive heatsinks are on the right side of the units, therefore it is recommended that Servodrives be mounted on the right side of the Power Supply first to promote cooling.
- Servodrives are mounted sequentially in descending order of continuous current rating (the Servodrive with the largest continuous current rating is closest to the Power Supply).
- Allow sufficient clearance around Power Supplies and Servodrives for airflow, and provide proper ventilation. Refer to the Specifications section for further information regarding Power Supply and Servodrive spacing.
- External regenerative discharge resistors should be mounted in an enclosure separate from the Power Supply and Servodrive enclosure, if possible. Regenerative discharge resistors can become extremely hot, and so proper ventilation must be provided.
- The thermal overload relay provided with the external regenerative discharge resistors should be mounted on a panel.

3.4 Power Supply Installation

3.4.1 Power Supply Sizing

The number of Servodrives which may be connected to a single Power Supply is determined by the Power Supply's main DC Bus output current capability (both continuous and peak) and control power supply capability. The number of Servodrives that can be connected to a Power Supply is limited to the smaller number determined using these criteria.

To determine the size Power Supply required for a system use the following three steps:

Step 1 Determine the continuous current requirements: The sum of the maximum continuous output current capability for all the Servodrives operating simultaneously must be less than or equal to the maximum continuous main DC Bus output power rating of the Power Supply to which they are connected. Refer to the Power Supply Output (BUS+ BUS-) Specifications and Servodrive Output (Ma Mb Mc) Specifications sections for the Power Supply and Servodrive output current ratings.

Step 2 Determine the peak current requirement: Repeat Step 1 to determine the sum of the maximum peak output current capability for all the Servodrives, and the Power Supply.

Step 3 Determine the control power requirements: Determine the number of Servodrives that can be connected to a single Power Supply (based on the control power supply) by referring to the following table. When connecting Servodrives of different current output ratings to the same Power Supply, the total number of Servodrives is limited to the number for the largest Servodrive in the group.

Power Supply	SAC-F03 to SAC-F20	SAC-F30 to SAC-F55
PAC-F12	3	-
PAC-F20(R)	3	-
PAC-F50R	7	6
PAC-F75R	7	6

For example: A system consisting of 4 SAC-F03 Servodrives, 2 SAC-F10 Servodrives, and a SAC-F30 Servodrive.

Step 1 *Max. Continuous Current* *= (4 * 3 amps) + (2 * 10 amps) + 30 amps*
= 62 amps

Step 2 *Max. Peak Current (2 sec.)* *= (4 * 6 amps) + (2 * 20 amps) + 60 amps*
= 124 amps

Step 3 *Total Number of Servodrives* *= 7*

A single PAC-75R is capable of meeting the systems maximum continuous current requirements (up to 75A continuous), but not the peak current requirements (up to 112A peak for 2 seconds). Also, the maximum number of Servodrives that can be connected to a single PAC-F75R is 6, when using a Servodrive with a continuous current capacity greater than 20 amps. Therefore, more than one Power Supply will be required.

Using two PAC-F50R's (one for the 4 SAC-F03's and the 2 SAC-F10's, and another for the SAC-F30) would provide sufficient main DC Bus and control power for this system.

NOTE: If you the ambient temperature of the Power Supplies and Servodrives is greater than 45°C, and/or the input power is 50 Hz, then the Power Supply and Servodrive continuous current output are derated. Refer to the Power Supply and Servodrive Output Specifications sections for further information.

If your application has a regenerative load component (refer to the Regenerative Load Conditions section of the Operation chapter) the Power

Supply must be sized to handle this. If you have any questions regarding Power Supply sizing call your ORMEC Sales and Applications Engineer.

3.4.2 Power Supply Terminal Block Connections

Terminal blocks are provided on the Power Supplies to connect the main AC input power to the Power Supply, and the main DC Bus output power to the Servodrive(s). If the Power Supply has support for an external regenerative discharge resistor[2], and the application requires one, terminals are provided for its connection. The following table briefly describes the individual functions of the Power Supply terminal block connections. Refer to Appendix A for a main power and main DC Bus connection diagram for a typical F-Series system. Refer to the External Regen Resistor Wiring section of this chapter for an external regen resistor connection diagram for a typical F-Series system.

Terminal	Function	Description
L1 L2 L3	Main Power	Three-phase 230 VAC, +/- 10%, 50/60 Hz.[1]
BUS+ BUS-	DC Bus Power	DC Bus Supply Power, 325 VDC (250-360 VDC)
GND	**Frame Ground**	**Must be securely attached to the Servodrive(s) and earth ground using braided copper wire.**
External Regen Resistor	Regenerative Resistor	An external regenerative resistor can be added if the Power Supply has support for it and it is required by the application.

[1] The continuous DC Bus Power output is derated when using 50 Hz main power, refer to the Power Supply Output Specifications section of the Specifications chapter for further information.

NOTE: **Captive screws are used in the L1, L2, L3, BUS+ and BUS- terminals of the PAC-F12 and PAC-F20(R). Do not attempt to remove these screws to use ring terminals.**

Use 600 VAC insulated wire to connect the Power Supply BUS+ and BUS- to the Servodrive(s), and to connect the Power Supply to the external regen resistor (if necessary). The suggested minimum wire gauges are shown in the following table.

[2] The PAC-F20R, PAC-F50R, and PAC-F75R have external resistor support.

	Minimum Wire Gauge		Terminal Block Screw Torques[1]			
Power Supply	BUS+ BUS- (AWG)	Ext. Regen Resistor (AWG)	L1 L2 L3 (in-lbs) [N-m]	BUS+ BUS- (in-lbs) [N-m]	Ext. Regen Resistor (in-lbs) [N-m]	Grounding (in-lbs) [N-m]
PAC-F12	14	n.a.	12 [1.36]	12 [1.36]	n.a.	12 [1.36]
PAC-F20	10	n.a.	12 [1.36]	12 [1.36]	n.a.	12 [1.36]
PAC-F20R	10	10	12 [1.36]	12 [1.36]	12 [1.36]	12 [1.36]
PAC-F50R	8	8	20 [2.26]	20 [2.26]	20 [2.26]	20 [2.26]
PAC-F75R	8	8	20 [2.26]	20 [2.26]	20 [2.26]	20 [2.26]

[1] All torque's are measured with the wire or terminal lug underneath the screw head.

3.4.3 Power Supply Input Power Considerations

F-Series Power Supplies can be operated directly on commercial power lines which supply between 207 and 253 VAC for the main power, and between 95 and 132 VAC for the control power. To prevent power line accidents due to grounding error, contact error, or to protect the system from a fire, circuit breakers or fuses must be installed according to the number and size (current capacity) of Power Supplies used. Slow-blow circuit breakers or fuses should be used because the capacitive DC Power Supplies draw substantial inrush current at power up.

		Recommended Main Bus Service[1]				
Power Supply	Main Bus Power Required[42]	Continuous	Peak (2 sec)	Peak (50 msec)	Recommended Main Bus Circuit Protection[3]	Recommended Control Power Service[3]
PAC-F12	4.8 KVA	12 A	24 A	50 A	12 A	1.5 A
PAC-F20(R)	8.0 KVA	20 A	40 A	80 A	20 A	1.5 A
PAC-F50R	20.0 KVA	50 A	75 A	100 A	50 A	3.0 A
PAC-F75R	30.0 KVA	75 A	112 A	150 A	75 A	3.0 A

[1] The line current ratings listed represent the recommended line capacity for 230 VAC, three phase service.

[2] The listed incoming power requirements are with the Servodrive(s) operating at peak power for 2 seconds.

[3] Fuses should be UL rated time delay type, such as BUSS FRN-R Series, sized according to NEC specifications.

3.4.4 Shielding, Power Line Filtering & Noise Suppression

The Servodrive uses high voltage switching power transistors in the main DC Bus circuit. When these transistors are switched, the $^{di}/_{dt}$ or $^{dv}/_{dt}$ switching noise may sometimes prove objectionable depending on the wiring and/or grounding method. The Servodrive also utilizes a microprocessor, which can be susceptible to power line interference caused either by the output

switching transistors or other equipment on the power line, such as welders, electrical discharge machines, induction heating equipment, etc. Careful layout of wiring and power line filtering will help prevent noise interference. Recommendations with respect to wiring and grounding are described later in this section.

It is recommended that line filters be installed to eliminate electro-magnetic interference coming into the system from the power line, as well as block switching noise from being transmitted back out to the power line from the Servodrives. The recommended line filters available from ORMEC are shown in Recommended Line Filters section.

3.4.5 Recommended Line Filters

Once the incoming power service is determined as described in the Power Supply Input Power Considerations section, the appropriate line filter can be selected from the following chart. For a single Power Supply installation, the line filter recommended is listed. In the case of a system using multiple Power Supplies, only one line filter is required per cabinet. Select the appropriate line filter by adding the incoming power line power recommendations in Specifications section.

Power Supply	Power Required[1]	Recommended Line Filter
PAC-F12	4.8 KVA	SAC-LF30
PAC-F20(R)	8.0 KVA	SAC-LF30
PAC-F50R	20.0 KVA	SAC-LF50
PAC-F75R	30.0 KVA	SAC-LF100

[1] The listed incoming power requirements are with the Power Supply operating at rated power.

3.4.6 Recommended Line Filter Wiring Methods

If the line filter connection or wiring methods are improper, it's effectiveness is significantly reduced. The following is the recommended line filter wiring approach:

1) Separate the input and output leads by a minimum of 10 inches (25 cm). Do not bundle them or run them in the same duct or wireway.

2) Do not bundle the ground lead with the filter output lines or other signal lines, and do not run them in the same duct.

3) Connect the filter ground lead with a single wire (preferably braid) to the enclosure or the control panel frame.

3.4.7 Power Supply Control Power/Fault Connections - Connector C1

Connector C1 is a 6 pin male connector, a mating connector and pins are provided with the Power Supply. These are used to connect the 115 VAC control power to the Power Supply, and the FAULT Contact to the emergency stop interlock circuit. Refer to the Power Supply Connectors section of the Specifications Chapter for connector part number information. The interface connections for connector C1 are described in the table that follows. Refer to Appendix A for a control power and emergency stop interlock connection diagram for a typical F-Series system.

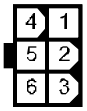


***Figure 1**, Power Supply Connector C1*

Function	Pin #	Description
115 VAC Input	2,3	Control power input.
FAULT Contact	1,4	Normally closed contact indicating that the Power Supply is ready for normal operation (no Alarm conditions are detected), 115 VAC, 1 amp.
115 VAC Output	5,6	115 VAC output for connection to Servodrive fan power[1] input connector C4.

[1] Fan power is required for the SAC-F20, SAC-F30, SAC-F40, and SAC-F55 Servodrives.

3.4.8 Power Supply Control Power Connections - Connector C2

Connector C2 is an 8 pin male connector. Refer to the Power Supply Connectors section of the Specifications Chapter for connector part number information. A CBL-FCP[3] is used to connect the control DC Bus output to the Servodrive(s). The interface connections for connector C2 are described in the table that follows. Refer to Appendix A for a control DC Bus connection diagram for a typical F-Series system. Refer to Appendix C for further information regarding cable CBL-FCP[3].

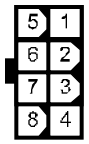


***Figure 2**, Power Supply Connector C2*

[3] CBL-FCP provides for a nominal unit spacing of 1".

Function	Pin #	Description
+18 VDC	1,5	Unregulated +18 VDC control power supply
-18 VDC	2,6	Unregulated -18 VDC control power supply
Common	3,7	Control power supply common
+10 VDC	4,8	Unregulated +10 VDC control power supply

3.4.9 External Regen Resistor Wiring

Terminal block connections are provided for wiring an external regen resistor to PAC-F20R, F50R, and F75R Power Supplies. An external overload protection relay is required and supplied with the regen resistors used with PAC-F50R and 75R Power Supplies. The PAC-F20R has an internal regen resistor fuse for overload protection, no additional external protection is supplied or required.

Refer to the Power Supply Terminal Block Connections section of this chapter for further information regarding external regen resistor wire gauges and screw torques. Refer to diagram which follows for further information regarding external regen resistor wiring.

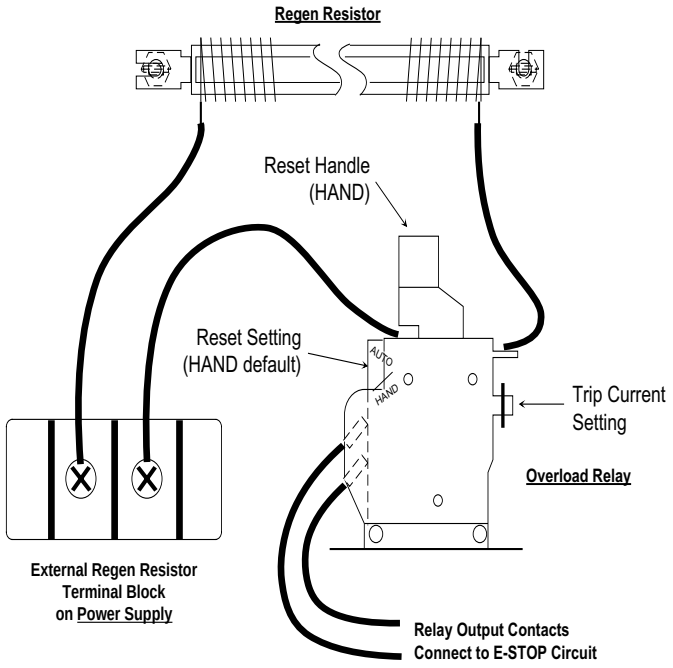


***Figure 3**, Regen Resistor Wiring Diagram*

Before installing an external regen resistor overload relay inspect the unit and verify that the overload trip current is configured as indicated in the table below. Also verify that the unit reset setting is configured for manual reset (HAND).

Regen Resistor	Trip Current Setting
SAC-FRR/0500	10.5 amps
SAC-FRR/1000A	15 amps
SAC-FRR/1000B	21 amps
SAC-FRR/2000	30 amps

Refer to the Regenerative Load Conditions section of the Operation chapter for further information regarding the shunt regulator circuit and regen resistor overload protection operation.

3.5 Servodrive Installation

3.5.1 Servodrive Terminal Block Connections

Terminal blocks are provided for connecting the AC output power to the Servomotor, and the main DC Bus input power from the Power Supply. The following table briefly describes the individual functions of the Servodrive terminal block connections. Refer to Appendix A for a Servomotor and main DC Bus power connection diagram for a typical F-Series system.

Terminal	Function	Description
Ma Mb Mc	Motor Power	Three-phase, approx. 230 VAC[1]
BUS+ BUS-	DC Bus Power	DC Bus Supply Power, 325 VDC (250 - 360 VDC)
GND	**Frame Ground**	**Must be securely attached to the Servodrive(s) and earth ground, using braided copper wire.**

[1] The continuous Motor Power output is derated when using 50 Hz main power, refer to the Servodrive Output Specifications section of the Specifications chapter for further information.

NOTE: Captive screws are used in the Ma, Mb, Mc, BUS+ and BUS- terminals of the SAC-F03, F06, F10, and F20 servodrives. Do not attempt to remove these screws to use ring terminals.

3.5.2 Recommended Motor and Servodrive Wiring Methods

1) When the motor is mounted to the machine and grounded through the machine frame, $^{dv}/_{dt}$ current flows from the PWM power supply through the floating capacity of the motor. To prevent the noise effects from this current, and also for safety, the motor housing (terminal D of the motor connector, the green wire of a CBL-FMAC# motor cable) should be connected to the frame of the Servodrive (designated GND), which should be directly grounded to the control panel frame using braided copper wire.

2) When motor wiring is contained in metal conduits, the conduits and boxes must be grounded. Use wires of 12 AWG or heavier for grounding to the case (preferably flat woven silver plated copper braid).

3) Route signal (including motor resolver) and power leads (including motor power) in separate conduits or ductwork, separated by a minimum of 10 inches (25 cm).

3.5.3 Servomotor Overload Protection

Thermal overload protection for the Servomotor is not provided internal to the Servodrive, and must be provided externally. External overload relays can be used to protect the Servomotor from overheating. Refer to the National Electric Code for information regarding the proper sizing of overload protection.

F-Series Servomotors have thermostats embedded in two of the three motor windings, which can be used as additional overload protection. NOTE: F-Series Servomotor thermostat contacts open when the motor winding temperature exceeds 170°C, and automatically close when the motor winding temperature drops below 132°C.

The overload protection should be wired such that it causes the Power Supply main power to be interrupted when an overload occurs, and remain interrupted (latched) until an operator reset occurs. Refer to the system wiring diagram in Appendix A.

3.6 Control Circuit Interconnections - Connector C1

Connector C1 is a 20 pin male connector. Refer to the Servodrive Connectors section of the Specifications Chapter for connector part number information. A CBL-AF is used to connect the Servodrive to a GN3-DSP Axis Module. The interface connections for connector C1 are described below. Refer to Appendix A for a connection diagram for a typical F-Series system. Refer to Appendix C for further information regarding cable CBL-AF.

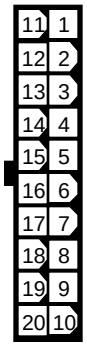
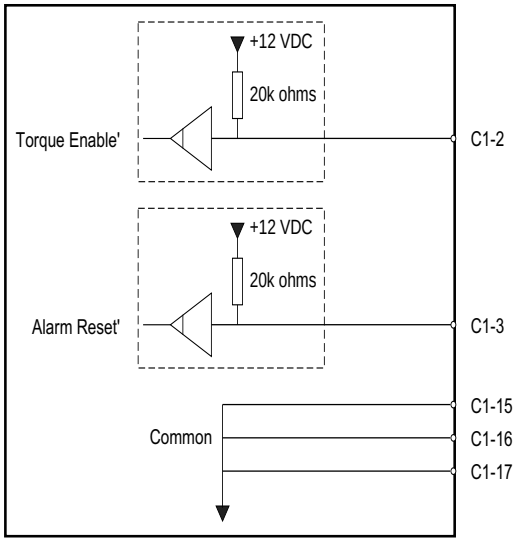


***Figure 4**, Servodrive Connector C1*

3.6.1 Torque Enable Interlock and Alarm Reset Input Signals

The Torque Enable interlock and Alarm Reset input signals each consist of a line receiver input with a 20K ohm pull-up resistor to +12 VDC. The ORMEC Motion Controller implementation of these signals pulls the Torque Enable input down to common to enable the Servodrive, and momentarily pulls the Alarm Reset input down to common to reset the Servodrive.

Signal	Pin #	Function	Description
T-ENABLE'	2	Torque Enable'	For normal motor operation this input must be asserted (0 VDC).
ALM-RESET'	3	Alarm Reset'	To reset the Servodrive after an alarm condition this input must be momentarily asserted (0 VDC).
DGND	15 16 17	Digital Ground	Interlock power common



F-Series Servodrive Torque Enable and Alarm Reset Signals (C1)

3.6.2 Interlock Output Signals

The Drive Ready interlock output signal is a relay contact. The ORMEC Motion Controller implementation of this output uses +10 VDC supplied by the Servodrive as the interlock voltage. The Drive Ready relay has the following specifications:

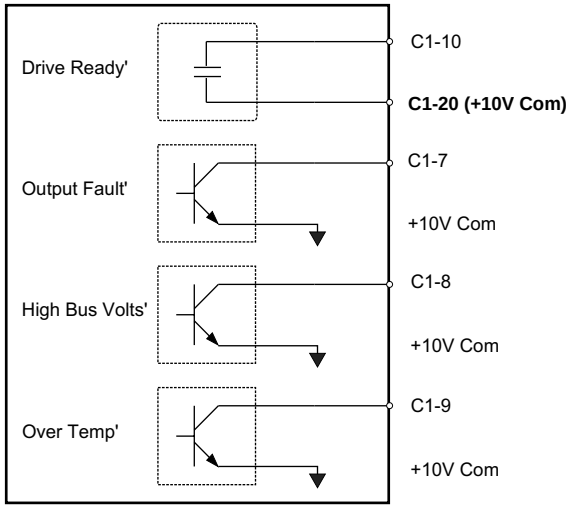
- Maximum Applied Voltage: 115 VAC
- Maximum Current Capability: 2 A

The other interlock output signals are open collector, active low, with the following specifications:

- Maximum Applied Voltage: 30 VDC
- Maximum Current Sink Capability: 25 ma

When attaching electromechanical relays to these outputs, a fly-back diode or other transient suppression device should be used across the relay coil.

Signal	Pin #	Function	Description
DRV-RDY' DRV-RDY	10 20	Drive Ready' Drive Ready	This output contact is normally open, and is closed when no Servodrive alarms are detected. For details on the alarms, refer to the Maintenance & Troubleshooting Chapter.
OUTPUT FAULT'	7	Output Fault'	This output is asserted if the servodrive has a high bus voltage or current fault alarm condition. For details on the alarms, refer to the Maintenance & Troubleshooting Chapter.
OVERVOLTS'	8	High Bus Voltage'	This output is asserted to indicate that the servodrive has a high bus voltage fault. For further details on the alarms, refer to the Maintenance & Troubleshooting Chapter.
OVERTEMP'	9	Over Temperature'	This output is asserted if the servodrive has an over temperature alarm condition, or RMS current limit fault. For further details on the alarms, refer to the Maintenance & Troubleshooting Chapter.



F-Series Servodrive Interlock Interface Output Signals (C1)

3.6.3 Current Command Input Signals

The Current command input signal is an analog voltage input used in the control of the output current, and therefore, torque of the Servodrive-Servomotor combination.

Signal	Pin #	Function	Description
DRV-CMD	1	Current Command	A bipolar analog voltage input where zero to +/-8 volts input results in servodrive output current from zero to plus or minus full output, and consequently torque from zero to plus or minus full output torque.
AGND	11	Current Command Common	This is the current command reference (zero) signal.

3.6.4 Velocity Monitor Signal

An analog output signal is provided for monitoring the speed of the Servomotor. This signal is driven by an operational amplifier.

Signal	Pin #	Function	Description
SPD MON	19	Speed Monitor	This analog signal is proportional to motor velocity, and is calibrated for approximately +/-8 volts at the maximum motor speed. Refer to the Specifications Chapter for Speed Monitor scaling information.

3.6.5 DC Power Supply Voltages Available on Connector C1

The DSP optical isolator inputs require a 4.5 VDC (minimum) input signal. The +10 VDC supplied by the Servodrive is used to achieve the required input signal voltage.

Signal	Pin #	Function	Description
+10 V	12	+10 VDC Output Power	Unregulated +10 VDC power supply.
Common	17	+10 VDC Common	Interlock power common.

3.7 Resolver and Thermostat Connections - Connector C2

Connector C2 is a 12 pin male connector. Refer to the Servodrive Connectors section of the Specifications chapter for further connector information. Connector C2 is the interface between the Servomotor resolver and the Servodrive. A CBL-FMACS, or CBL-FMACL depending on the Servomotor, is used to connect the Servomotor resolver to the Servodrive. Refer to Appendix A for a connection diagram for a typical F-Series system. Refer to

Appendix D for further information regarding CBL-FMACS and CBL-FMACL cables.

3.8 Control Power Connections - Connector C3

Connector C3 is an 8 pin male connector. Refer to the Servodrive Connectors section of the Specifications Chapter for connector part number information. A CBL-FCP[4] is used to connect the control DC bus input from the Power Supply. The interface connections for connector C3 are described in the following table. Refer to Appendix A for a connection diagram for a typical F-Series system. Refer to Appendix C for further information regarding cable CBL-FCP.

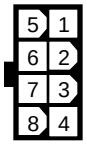


***Figure 5**, Servodrive Connector C3*

Function	Pin #	Description
+18 VDC	1,5	Unregulated +18 VDC control power supply (+14 to +26 VDC)
-18 VDC	2,6	Unregulated -18 VDC control power supply (-14 to -26 VDC)
Common	3,7	Control Power supply common
+10 VDC	4,8	Unregulated +10 VDC control power supply (+6.5 to 14 VDC)

3.9 Fan Power - Connector C4

Connector C4 is a 4 pin male connector. Refer to the Servodrive Connectors section of the Specifications Chapter for connector part number information. To simplify installation, a fan power cable is provided with Servodrives requiring fan power. This cable can be inserted into the connector provided with the Power Supply (C1), or another Servodrive (C4) requiring fan power, as needed. The interface connections for connector C4 are described in the following table. Refer to Appendix A for a connection diagram for a typical F-Series system.

***Figure 6**, Servodrive Connector C4*

[4] CBL-FCP provides for a nominal unit spacing of 1".

Function	Pin #	Description
115 VAC Input	1,2	115 VAC input for connection to fan power output from Power Supply connector C1, or Servodrive connector C4.
115 VAC Output	3,4	115 VAC output for connection to fan power on other Servodrives in the system, if needed.

3.10 Quadrature Position Feedback Signals - Connector C5

Quadrature position feedback signals are provided for use with position control and monitoring electronics. ORMEC motion control systems use differential line driver outputs for feedback signals.

Connector C5 is an 8 pin male connector. Refer to the Servodrive Connectors section of the Specifications Chapter for connector part number information. A CBL-AF is used to connect the quadrature position feedback signals to a GN3-DSP Axis Module The interface connections for connector C5 are described in the following table. Refer to Appendix A for a connection diagram for a typical F-Series system. Refer to Appendix C for further information regarding cable CBL-AF.

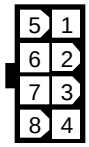


***Figure 7**, Quadrature Position Feedback Signals Connector C5*

Signal	Pin #	Function	Description
ENCA ENCA'	1 5	Encoder Feedback Channel A	Quadrature position encoder outputs after frequency division; driven with differential line drivers (TI 75174), to be received by differential line receivers (TI 75115 or equivalent)
ENCB ENCB'	2 6	Encoder Feedback Channel B	
ENCZ ENCZ'	3 7	Encoder Reference Channel Z	Once per motor revolution reference signal; driven with differential line drivers (TI 75174).

Note: These differential encoder signals are wired with individual twisted pairs within a shielded cable.

3.11 Power Supply and Servodrive Power Dissipation at Rated Output

The Servodrive and Power Supply power dissipation information listed below is provided to assist in the specification of cabinet cooling system requirements.

Servodrive Model	Total Dissipation (watts)
SAC-F03	40
SAC-F06	65
SAC-F10	95
SAC-F20	175
SAC-F30	255
SAC-F40	335
SAC-F55	445

Power Supply Model	Continuous Internal Dissipation (watts)	Internal Regeneration Resistor (watts)	Total Dissipation (watts)
PAC-F12	60	40	100
PAC-F20	90	40	130
PAC-F20R	90	none[1]	90
PAC-F50R	175	none[1]	175
PAC-F75R	250	none[1]	250

[1] Regenerative discharge resistor external to unit. If an external regenerative discharge resistor is used, add it's dissipation rating to the total for the Power Supply

3.12 Motor Installation

Before mounting the Servomotor: Dissolve and remove the anti-corrosive paint on the shaft extension and flange surface with paint thinner before attaching the motor to the driven machine.

3.12.1 Motor Use and Environment

A standard F-Series Servomotor (IP65) is designed for use as described below:

- Either horizontal or vertical mounting orientation
- Indoors, clean and dry
- Free from corrosive and/or explosive gases or liquids

- If the location is subject to excessive water or oil, protect the motor with a cover. The motor can withstand a small amount of splashed water or oil.
- Accessible for inspection and cleaning
- Ambient Temperature: 0°C to +40°C

3.12.2 Coupling the Servomotor to the Load

Good alignment of motor and the driven machine is essential to prevent vibration, increase bearing and coupling life, and to prevent shaft and bearing failures.

With a direct drive application a torsionally rigid flexible coupling should be used. Timing belts and gear boxes are also commonly used in servo applications. Shaft loading should be kept to a minimum. The allowable shaft bearing loading is listed in the Specifications Section.

In either case, it is preferable to attach the coupling or pulley to the shaft with a clamping arrangement rather than transmit torque through the keyway, because of the reversing shock torques which the Servomotor can generate. A number of mechanical approaches afford this type of attachment including tapered hubs, split hubs, ringfeder devices, etc.

The motors are designed for face mounting, and the structural integrity of the mounting can be critical to obtaining the maximum performance from your Servomotor application.

Chapter 4
Operation

4 Operation

4.1 Power On and Off Sequencing

For proper system operation, power must be supplied to the control power circuit first, followed by the main circuit, or simultaneously supplied to both. On power-down (including momentary power failure), the power should be either simultaneously disabled, or the main power removed first, followed by the control power.

The main power circuit should be arranged so that it is interlocked with the Controller NO FAULT and Power Supply FAULT relays. Therefore, when a Controller, Servodrive, or Power Supply alarm is detected, either the Controller NO FAULT or Power Supply FAULT relay disables the system main circuit power.

The recommended interlock approaches for both single and multiple axes are detailed in Appendix A.

Note the features of the recommended interlock circuit:

1) The E-Stop switch, powered by 115 or 230 VAC, must conduct current for the Servomotor to provide output torque. The recommended E-Stop switch is a maintained contact red mushroom-head push-button, which must be manually pulled out (reset) after it has been pressed in (asserted).

2) The momentary contact E-Stop Reset push-button switch must be asserted after all power is applied and the E-Stop switch is closed. The E-Stop Reset switch must be closed long enough for the Controller NO FAULT (NF) and Power Supply FAULT relays to "pull-in", so that the main power contactor coil circuit is energized.

3) If the E-Stop switch is pressed (asserted) the main circuit power is disconnected, and the Controller then disables the T-ENABLE' signal. When power is applied, it will take up to 1 second (normally 200 to 300

msec) to initialize the Power Supply, and for the FAULT Contact to be closed, allowing main power to be reapplied.

4) If any Alarm condition occurs within the Servodrive the DRV-RDY output is disabled, and the main circuit power is disconnected by opening of the Controller NO FAULT relay. In this case, the nine LEDs on the front of the Servodrive will indicate the Servodrive status, and the type of problem detected. To reset a High Bus Voltage Alarm the main Bus input power must be disabled for at least 5 minutes, or until the power stage capacitors are fully discharged. All other alarm conditions are cleared by asserting the ALM-RESET' input.

5) If any Alarm condition occurs within the Power Supply, the main circuit power is disconnected, by opening of the Power Supply FAULT relay. In this case the three or four LEDs (depending on the model Power Supply) on the front of the Power Supply will indicate the unit's status, and the type of problem detected. To reset Power Supply alarm conditions the main Bus input power must be disabled for at least 5 minutes, or until the power stage capacitors are fully discharged.

6) Not only must any Alarm condition, including E-Stop, be cleared before motor power can be restored, but the E-Stop Reset push-button must then be depressed long enough for all the relays to pull-up again.

4.2 Current Command Input

The Servodrive is configured for torque or current command input. This determines the output current of the Servodrive, and therefore the output torque of the motor. The output torque is proportional to the ±8 volt analog input signal (DRV-CMD). The peak torque of the Servomotor is obtained when DRV-CMD is at approximately 8 volts.

4.3 Overload Characteristics

The overload protection circuitry built into the Servodrive prevents the motor and Servodrive from RMS power overload. Peak currents of up to 200% of the Servodrive's RMS rating are typical for this equipment, with a 200% over current typically allowed for two seconds.

Should an overload current greater than 100% of rated current be drawn for too long, the protective circuitry will cause a RMS Current Limit fault on the Servodrive. This fault condition is indicated by assertion of the RMS Current Limit LED, only while Servodrive is commanding current in excess of the RMS limit. The Over Temperature LED and output signal are also asserted during a RMS Current Limit, and can be reset by asserting the ALM-RESET' signal.

4.4 Resolver Resolution and Accuracy

An F-Series Servodrive uses resolver signals from it's Servomotor to measure the absolute rotor shaft position (within a revolution) for commutation purposes. The combined accuracy of the resolver and R to D circuitry are listed in the following table.

	14 Bit R/D (A)	12 Bit R/D (B)
Max. Motor Speed	3150 RPM	7500 RPM
Resolution	4,096 lines/rev 16,384 counts/rev	1,024 lines/rev 4,096 counts/rev
Accuracy	+/- 15.32 arc min. +/- 0.25 degrees +/- 5.7 counts	+/- 19.27 arc min. +/- 0.32 degrees +/- 1.8 counts
Repeatability	1.32 arc min. 0.022 degrees 1.0 count	5.27 arc min. 0.088 degrees 1.0 count

To determine the R/D converter resolution of your Servodrive refer to the first option letter code of the Servodrive's part number. For example: A *SAC-F03/***A***01* has 14 bit R/D converter, a *SAC-F03/***B***01* has a 12 bit R/D converter.

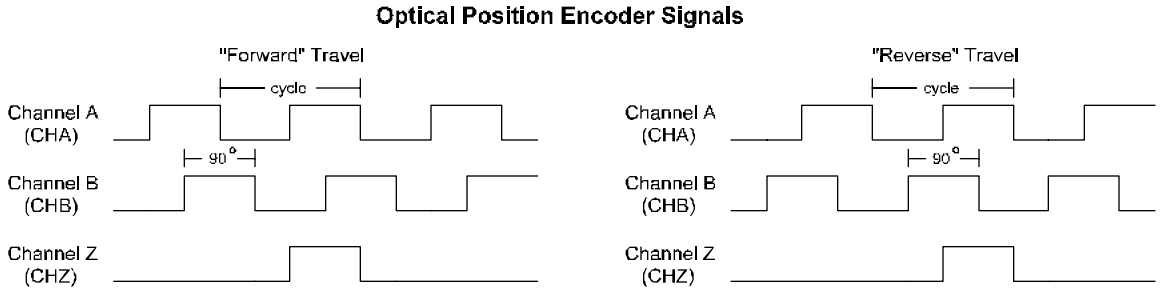
Resolver errors are cyclical, meaning that similar errors occur in the same rotor shaft position every revolution. These errors are not cumulative, meaning that the errors do not add up over multiple revolutions.

Because ORMEC motion controllers do not have a resolver interface, the motor resolver information is converted into quadrature position signals for use by the motion controller. Refer to the Quadrature Output Signals section for further information regarding the quadrature position signals.

4.5 Quadrature Output Signals

Quadrature position signals for "Forward" and "Reverse" travel are illustrated in the following figure. These signals are derived from the motor resolver information.

Channel A and Channel B are phase quadrature output signals, which allow the Servodrive and associated digital positioning electronics to determine both travel distance and direction. Programmable motion controllers, such as ORMEC's, typically decode each transition of both encoder channels, yielding a resolution of four times the linecount specification per revolution e.g. A position encoder with 4096 linecount, when decoded by an ORMEC Controller yields a positioning resolution of 16,384 cts/rev.



NOTE: Channel Z (once per revolution marker channel) is synchronized with Channel A.

4.6 Regenerative Load Conditions

When conditions exist such that the direction of power flow is from the machine into the motor, the motor acts as a generator. This can occur for a variety of reasons including:

1) Decelerating the machine faster than it would coast. This is especially critical at high speeds and with large inertias;

2) Using the motor to lower a load that is not counterbalanced, and;

3) Using the motor to control an unwind stand for rolls of material, where the tension in the web causes the motor to have to hold back while moving forward.

If your application has a regenerative load a shunt regulator and regenerative discharge resistor are required. For assistance determining if your application has regenerative load component contact you ORMEC Sales and Applications Engineer.

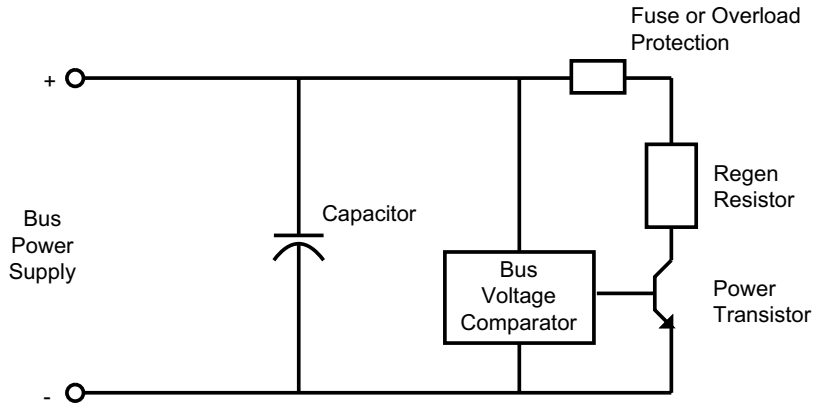
4.6.1 Shunt Regulator

The Servodrive uses PWM sine-wave technology to deliver power to the motor. The switching of the PWM amplifier, in conjunction with the inductances and capacitances in the motor and the output circuitry can cause the Power Supply to gain voltage as energy is generated and returned to the drive from the machine. The Power Supply has no mechanism for returning energy to the power line in these cases where the motor acts as a generator, but it does have a shunt regulator for dissipating this excessive energy build-up.

The shunt regulator consists of a voltage comparator, a switching transistor and a shunt resistor. When the voltage comparator detects excess power supply voltage (at approximately 390 VDC) it turns on the transistor, dissipating excess energy from the Power Supply capacitor to the shunt resistor. The amount of energy that it can dissipate is dependent on the current capability of the switching transistor and the wattage specification of the regen resistor.

For assistance determining your application's regenerative discharge load contact your ORMEC Sales and Applications Engineer.

Shunt Regulator Circuitry & Specificaitons



Power Supply	Internal Regen Resistor		Power Transistor		Peak Power[1] (kW)
	Resistance (ohms)	Power (watts)	Continuous. Current (amps)	Peak Current[1] (amps)	
PAC-F12	12.5	40	12	50	200
PAC-F20	12.5	40	12	50	200
PAC-F20R	External Only[2]		12	75	350
PAC-F50R	External Only[2]		30	100	400
PAC-F75R	External Only[2]		30	200	780
[1] Peak current and power available for 500 msec max.					
[2] No internal shunt regulation resistor provided for this model Power Supply.					

The following table indicates which regen resistors can be used with each Power Supply equipped with the external regen resistor option.

Regen Resistor	**SAC-FRR/0700**	**SAC-FRR/0500**	**SAC-FRR/1000**	**SAC-FRR/2000**
Resistance (ohms)	5.8	4.5	4.4	2.2
PAC-F20R	x			
PAC-F50R		x	x	
PAC-F75R		x	x	x

4.6.2 Shunt Regulator Overload Protection

Internal shunt regulator overload protection is provided for the PAC-F10 and PAC-F20(R) Power Supplies, external protection is provided for the PAC-F50R and PAC-F75R Power Supplies. External shunt regulator overload protection should be wired such that an overload interrupts the main circuit power. Refer to Appendix A for further information regarding shunt regulator overload circuit wiring.

If regeneration is excessive for a PAC-F10 or PAC-F20(R) a High Bus Voltage fault may occur, and/or the Regen Fuse in the Power Supply might blow. If the Regen Fuse is blown, the Regen Fuse LED on the Power Supply will be

illuminated, and the fuse will have to be replaced. Refer to the Specifications section for replacement regen resistor fuse information. To reset the Power Supply after a High Bus Voltage fault main power to the unit must be disabled until the main DC Bus power capacitors have discharged.

If the regeneration is excessive for a PAC-F50R or PAC-F75R an Over Temperature fault may occur, and/or the external regen resistor thermal overload relay contacts might open. If the thermal overload relay contacts open the relay may be reset by pressing the rod located in the top of the unit. To reset the Power Supply after an Over Temperature fault main power to the unit must be disabled until the main DC Bus power capacitors have discharged.

If a shunt overload occurs, the following actions may resolve the problem:

- Reduce the commanded current limit for the Controller.
- Slow down the deceleration curve.
- Decrease the maximum motor speed.
- Change the motor to load revolutions ratio.

Chapter 5
Getting Started

5 Getting Started

5.1 Test Run

Before doing a test run, check the following points listed in this section. Correct any problems before proceeding.

5.1.1 Servomotor Check

Before test run, check the following.

- Motor mounting and grounding are correct.
- Bolts and nuts are tight.
- For motors with oil seals (IP67), the seals are not damaged and are properly lubricated.
- Motor and Resolver Cables are properly attached.

5.1.2 Power Supply and Servodrive Check

- The Power Supply main power voltage should be 230 VAC, **WITH AN ABSOLUTE MINIMUM OF 207 VAC AND ABSOLUTE MAXIMUM OF 253 VAC. CHECK POWER BEFORE APPLYING IT TO THE POWER SUPPLY!!!!**
- The Power Supply control and fan power voltage should be 115 VAC, **WITH AN ABSOLUTE MINIMUM OF 95 VAC AND ABSOLUTE MAXIMUM OF 132 VAC. CHECK POWER BEFORE APPLYING IT TO THE POWER SUPPLY!!!!**
- Connections are firmly seated.
- Main DC Bus power (BUS+ BUS-) connections are correct.

- Fuse connection and grounding are correct.
- Motor cable lug termination's are tight.
- Motor wiring is correct.
- The main power interlock circuit disables main power under a Power Supply or Servodrive alarm condition.

5.1.3 Preparation for Test Run

During test run, the driven machine should not be attached to the Servomotor. If it is necessary to start with the driven machine connected to the motor, proceed with great care.

- After checking items above, turn on the power.
- Enable the main power circuit and measure main DC Bus voltage.
- When the Interlock Input Signals are correct, the power circuit in the Servodrive will operate and the motor is ready to run.
- The Alarm Status Indicator LEDs, described in the Maintenance & Troubleshooting Section provides several status indications.

Chapter 6
Specifications

6 Specifications

Power Supplies covered by this manual:

PAC-F12	PAC-F20R
PAC-F20	PAC-F50R
	PAC-F75R

Servodrives covered by this manual:

SAC-F03	SAC-F30
SAC-F06	SAC-F40
SAC-F10	SAC-F55
SAC-F20	

6.1 F-Series Motors Overview

Maximum Speed:	7500 RPM
Continuous stall torque's:	7 to 960 lb-in (0.84 to 109 N-m)
Peak Torque's:	18 to 1920 lb-in (2.02 to 236 N-m)
Peak Acceleration:	up to 33,529 rad/sec^2
Rated Power:	0.31 to 20.5 HP
Position Encoder Resolution:	16,384cts/rev (4,096 lines/rev) up to 3150 RPM 4,096 cts/rev (1024 lines/rev) up to 7500 RPM
Thermostat Set Point:	Contact opens when the winding temperature is 170°C (+/-5°C) or higher, and automatically close when the temperature is then reduced below 132°C (+/-5°C).
Thermostat Contact Rating:	120 VAC, 4 amps.

6.2 General Power Supply Specifications

Environmental Specifications

Operating Temperature:	0 to +45°C[1]
Storage Temperature:	-20 to +70°C
Operating and Storage Humidity:	10% to 90%, non-condensing

Mechanical Specifications

Mounting Method:	Vertically oriented panel mounting, four 10-32 (M5) screws. Provide a nominal clearance of 1" (25 mm) (0.8", 20 mm min.) on either side and at least 1.5 inches (40 mm) above and below each unit.

Electrical Specifications

Incoming Main Power Line Voltage: (Three Phase, 50/60 Hz)	230 VAC
Minimum Incoming Main Power Line Voltage:	207 VAC
Absolute Maximum Incoming Main Power Line Voltage:	253 VAC
Incoming Control Power Line Voltage: (Single Phase, 50/60 Hz)	120 VAC
Minimum Incoming Control Power Line Voltage:	95 VAC
Absolute Maximum Incoming Control Power Line Voltage:	132 VAC
Rated Main DC Bus Voltage:	325 VDC
Shunt Regulator Activation Main DC Bus Voltage:	390 VDC
High Bus Voltage Fault Main DC Bus Voltage:	430 VDC
Unregulated Control DC Bus Voltages:	
+/- 18 VDC Power Supply	+/-14.5 to +/-26 VDC
+ 10 VDC Power Supply	+ 6.5 to 14 VDC
Fault Contact Rating:	115 VAC, 1 A

[1] Operation up to 55°C is possible, refer to the Power Supply Output Specifications section of this chapte for further information.

6.3 General Servodrive Specifications

Environmental Specifications

Operating Temperature:	0 to +45°C[1]
Storage Temperature:	-20 to +70°C
Operating and Storage Humidity:	10% to 90%, non-condensing

Mechanical Specifications

Mounting Method:	Vertically oriented panel mounting, four 10-32 (M5) screws. Provide a nominal clearance of 1" (25 mm) (0.8", 20 mm min.) on either side and at least 1.5 inches (40 mm) above and below each unit.

Electrical Specifications

Rated Main DC Bus Voltage:	325 VDC
Minimum Main DC Bus Voltage:	250 VDC
Absolute Maximum Main DC Bus Voltage:	360 VDC
Unregulated Control DC Bus Voltages:	
+/- 18 VDC Power Supply	+/-14.5 to +/-26 VDC
+ 10 VDC Power Supply	+ 6.5 - 14 VDC
Fan Power: (required for SAC-F20, F30, F40 & F55)	95-132 VAC (at 0.5 A)
High Main DC Bus Voltage Fault Bus Voltage:	430 VDC
Low Main DC Bus Voltage Fault Bus Voltage:	125 VDC
Resolver Signal Voltage:	12 volts peak to peak (8.5 volts RMS)
Resolver Signal Frequency:	7.0 kHz (+/- 500 Hz)
Input Interlock Circuitry:	
Input Voltage Requirements:	Internal 20K Ohm pull-up resistor to +12 VDC
Input Current (at each input):	1 ma typical
Output Interlock Circuitry:	
Maximum Applied Voltage:	+30 VDC
Maximum Current Sink Capability:	-25 ma

[1] Operation up to 55°C is possible, refer to the Servodrive Output Specifications section of this chapter for further information.

6.4 Power Supply Output (BUS+ BUS-) Specifications

Power Supply (60 Hz, 45°C)	**Rated Output Power** (kW)	**Continuous Current** (A)	**Peak Current 2.0 sec** (A)	**Peak Current 50 msec** (A)
PAC-F12	3.6	12	24	48
PAC-F20(R)	6.0	20	40	80
PAC-F50R	15.0	50	75	100
PAC-F75R	22.5	75	112	150

Use the following table to determine continuous current for operation in ambient temperatures above 45°C, and/or 50 Hz.

Power Supply	**Cont. Current** 60 Hz, 55°C (A)	**Cont. Current** 50 Hz, 45°C (A)	**Cont. Current** 50 Hz, 55°C (A)
PAC-F12	12.0	9.6	9.6
PAC-F20(R)	20.0	16.0	16.0
PAC-F50R	45.0	45.0	40.0
PAC-F75R	67.5	67.5	60.0

6.5 Servodrive Output (Ma Mb Mc) Specifications

Servodrive (60 Hz, 45°C)	**Rated Output Power** (KVA)	**Continuous Current** (Amps RMS)	**Peak Current 2.0 sec** (Amps RMS)
SAC-F03	1.1	3.0	6.0
SAC-F06	2.2	6.0	12.0
SAC-F10	3.6	10.0	20.0
SAC-F20	7.3	20.0	40.0
SAC-F30	11.0	30.0	60.0
SAC-F40	14.5	40.0	80.0
SAC-F55	20.0	55.0	110.0

Use the following table to determine continuous current for operation in ambient temperatures above 45°C, and/or 50 Hz.

Servodrive	**Cont. Current** 60 Hz, 55°C (Amps RMS)	**Cont. Current** 50 Hz, 45°C (Amps RMS)	**Cont. Current** 50 Hz, 55°C (Amps RMS)
SAC-F03	2.4[1]	3.0	2.4 [1]
SAC-F06	4.8 [1]	6.0	4.8 [1]
SAC-F10	8.0 [1]	10.0	8.0 [1]
SAC-F20	16.0 [1]	20.0	16.0 [1]
SAC-F30	24.0 [1]	24.0 [1]	19.2[2]
SAC-F40	32.0 [1]	32.0 [1]	25.6 [2]
SAC-F55	44.0 [1]	44.0 [1]	35.2 [2]

[1] Derate continuous motor torque 20%.

[2] Derate continuous motor torque 36%.

6.6 Power Supply Fuses

Refer to the Maintenance & Troubleshooting section for instructions for replacing Power Supply fuses.

Regen Resistor	**PAC-F12**	**PAC-F20**	**PAC-F20R**	**PAC-F50R**	**PAC-F75R**
Current Rating (amps)	8	8	15	Overload protection is a relay supplied with the regen resistor.	
Mfr. Part Number[1]	KLK-8	KLK-8	KLK-15		
Locator	132	132	132		
+/-18 VDC Control Power					
Current Rating (amps)	1.5	1.5	1.5	4	4
Mfr. Part Number[1]	31201.5	31201.5	31201.5	312004	312004
Locators (+ / -)	99 / 102	99 / 102	99 / 102	40 / 41	40 / 41
+10 VDC Control Power					
Current Rating (amps)	4	4	4	8	8
Mfr. Part Number[1]	312004	312004	312004	312008	312008
Locator	126	126	126	19	19
Soft-Start					
Current Rating (amps)	n.a.	n.a.	n.a.	10	10
Mfr.. Part Number[1]	n.a.	n.a.	n.a.	312010	312010
Locator	n.a.	n.a.	n.a.		

[1] Manufacturers part numbers for Littelfuse.

6.7 Power Supply Connectors

Power supply connectors C1 and C2 are manufactured by Molex, with the Molex and ORMEC part numbers indicated in the following table. Molex crimping tool 11-01-0197, and pins 39-00-0039 (ORMEC P/N CON368) are used for assembly.

Locator	Description	# Pins	Receptacle[1]	Plug[2]	ORMEC P/N
C1	Control Power AC Input & Fault Contact	6	39-29-1067	39-01-2065	CON372
C2	Control Power DC Supply	8	39-29-1087	39-01-2085	CON371

[1] Receptacle is the male connector housing provided on the Power Supply.

[2] Plug is the female connector housing provided with the Power Supply for wiring by the user.

6.8 Servodrive Connectors

Servodrive connectors C1 through C5 are manufactured by Molex, with the Molex and ORMEC part numbers indicated in the following table. Molex crimping tool 11-01-0197, and pins 39-00-0039 (ORMEC P/N CON368) are used for assembly.

Locator	Description	# Pins	Receptacle[1]	Plug[2]	ORMEC P/N
C1	Control Interlock	20	39-29-1207	39-01-2205	CON369
C2	Motor Resolver Feedback	12	39-29-1127	39-01-2125	CON370
C3	Control Power DC Supply	8	39-29-1087	39-01-2085	CON371
C4	Fan Power	4	39-29-1027	39-01-2045	n.a.
C5	Quadrature Output Signals	8	39-29-1087	39-01-2085	CON371

[1] Receptacle is the male connector housing provided on the Servodrive.

[2] Plug is the female connector housing provided on the ORMEC supplied cables. Individual plugs are not supplied with the servodrives.

6.9 Servomotor Connectors

	Motor			Resolver		
Servomotor	**# Pins**	**Receptacle**[1]	**Plug**[2]	**# Pins**	**Recepticle**[1]	**Plug**[2]
MAC-F007	5	MS-3112E-14-5P	MS-3116E-14-5S	19	MS-3112E-14-19P	MS-3116E-14-19S
MAC-F015	5	MS-3112E-14-5P	MS-3116E-14-5S	19	MS-3112E-14-19P	MS-3116E-14-19S
MAC-F020	4	MS-3112E-14-5P	MS-3116E-14-5S	19	MS-3112E-14-19P	MS-3116E-14-19S
MAC-F040	4	MS-3112E-14-5P	MS-3116E-14-5S	19	MS-3112E-14-19P	MS-3116E-14-19S
MAC-F060	4	MS-3102E-18-10P	MS-3106-E-18-10S	19	MS-3102E-22-14P	MS-3106E-22-14S
MAC-F115	4	MS-3102E-18-10P	MS-3106-E-18-10S	19	MS-3102E-22-14P	MS-3106E-22-14S
MAC-F155	4	MS-3102E-22-22P	MS-3106E-22-22S	19	MS-3102E-22-14P	MS-3106E-22-14S
MAC-F265	4	MS-3102E-22-22P	MS-3106E-22-22S	19	MS-3102E-22-14P	MS-3106E-22-14S
MAC-F400	4	MS-3102E-22-22P	MS-3106E-22-22S	19	MS-3102E-22-14P	MS-3106E-22-14S
MAC-F700	4	MS-3102E-22-22P	MS-3106E-22-22S	19	MS-3102E-22-14P	MS-3106E-22-14S
MAC-F960	4	MS-3102E-22-22P	MS-3106E-22-22S	19	MS-3102E-22-14P	MS-3106E-22-14S

[1] Receptacle is the male connector provided on the Servomotor.

[2] Plug is the female connector provided with the motor or resolver cable.

6.10 MAC-F Series Servomotors Specifications

PERFORMANCE[1]	Units	F007A		F015A	
Maximum Speed[2]	RPM	3,150	7,500	3,150	5,600
Continuous Stall Torque	lb-in (N-m)	7 (0.84)	7 (0.84)	14 (1.55)	14 (1.55)
Rated Torque at Max. Speed	lb-in (N-m)	6 (0.69)	6 (0.69)	14 (1.53)	14 (1.53)
Rated Power at Max. Speed	HP	0.31	0.73	0.68	1.2
	watts	230	540	500	900
Peak Torque	lb-in (N-m)	18 (2.02)	18 (2.02)	26 (2.88)	26 (2.88)
Continuous Stall Torque/Inertia	rad/sec^2	27,193	27,193	33,529	33,529
MECHANICAL					
Moment of Inertia	lb-in-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	0.274 (0.309)	0.274 (0.309)	0.408 (0.461)	0.408 (0.461)
Friction Torque, static	lb-in (N-m)	0.4 (0.04)	0.4 (0.04)	0.5 (0.05)	0.5 (0.05)
Servomotor Weight	lbs (kg)	5.5 (2.5)	5.5 (2.5)	7.0 (3.2)	7.0 (3.2)
Mounting Bolt Diameter	inches (mm)	2.953 (75)	2.953 (75)	2.953 (75)	2.953 (75)
Pilot Diameter	inches (mm)	2.362 (60)	2.362 (60)	2.362 (60)	2.362 (60)
Shaft Diameter	inches (mm)	0.433 (11)	0.433 (11)	0.551 (14)	0.551 (14)
Length, mounting face to rear	inches (mm)	7.2 (183)	7.2 (183)	8.4 (214)	8.4 (214)
Maximum Shaft Load[3] (Centered 1" from mounting face)	lbs (N)	44 (195)	44 (195)	47 (209)	47 (209)
ELECTRICAL					
Servodrive Model Number	SAC-	F03/A01	F03/B01	F03/A02	F03/B02
Torque Sensitivity, K_t	lbs-in/amp (N-m/amp)	3.12 (0.353)	3.12 (0.353)	4.54 (0.512)	4.54 (0.512)
Continuous Current	amps	2.4	2.4	3.0	3.0
Peak Current (2 seconds)	amps	6.0	6.0	6.0	6.0
Servodrive Weight	lbs (kg)	6.5 (3.0)	6.5 (3.0)	6.5 (3.0)	6.5 (3.0)
THERMAL					
Ambient Temperature	deg. C	40	40	40	40
Thermal Time Constant	minutes	10	10	11	11
Insulation Class		H	H	H	H
RESOLVER & TACH					
Quadrature Output Resolution[4]	linecount	4096	1024	4096	1024
Tachometer sensitivity	volts/Krpm	2.5	1.1	2.5	1.4

[1] Ratings are obtained with Servomotor ambient temperature at 40°C. Refer to the Servodrive Output Specifications section of this chapter to determine continuous current (torque) for operation in ambient temperatures between 0°C and 55°C, and/or 50 Hz.

[2] Maximum motor speed is determined by both the maximum speed rating of the motor and the servodrive resolver R/D circuitry. The Servodrive parameter indicates which servodrive is to be used with a motor at the specified max. speed.

[3] Shaft loads may be both radial and axial, such that **RADIAL + 2 * AXIAL < Maximum Shaft Load**.

[4] Effective encoder resolution is four times the stated linecount for motion controllers which decode every edge of the "A" and "B" quadrature encoder channels.

MAC-F Series Servomotor Specifications

PERFORMANCE[1]	Units	F020A		F040A	
Maximum Speed[2]	RPM	3,150	3,800	3,150	3,600
Continuous Stall Torque	lb-in (N-m)	22 (2.44)	22 (2.44)	40 (4.47)	40 (4.47)
Rated Torque at Max. Speed	lb-in (N-m)	22 (2.44)	22 (2.44)	37 (4.15)	37 (4.15)
Rated Power at Max. Speed	HP	1.1	1.3	1.8	2.1
	watts	800	1000	1,400	1,600
Peak Torque	lb-in (N-m)	41 (4.61)	41 (4.61)	89 (10.0)	89 (10.0)
Continuous Stall Torque/Inertia	rad/sec^2	24,490	24,490	25,882	25,882
MECHANICAL					
Moment of Inertia	$lb\text{-}in\text{-}sec^2 x10^{-3}$ $(kg\text{-}m^2 x10^{-4})$	0.88 (0.996)	0.88 (0.996)	1.53 (1.73)	1.53 (1.73)
Friction Torque, static	lb-in (N-m)	0.7 (0.08)	0.7 (0.08)	0.8 (0.10)	0.8 (0.10)
Servomotor Weight	lbs (kg)	9.0 (4.1)	9.0 (4.1)	13.6 (6.2)	13.6 (6.2)
Mounting Bolt Diameter	inches (mm)	3.937 (100)	3.937 (100)	3.937 (100)	3.937 (100)
Pilot Diameter	inches (mm)	3.150 (80)	3.150 (80)	3.150 (80)	3.150 (80)
Shaft Diameter	inches (mm)	0.551 (14)	0.551 (14)	0.551 (14)	0.551 (14)
Length, mounting face to rear	inches (mm)	8.5 (215)	8.5 (215)	10.1 (255)	10.1 (255)
Maximum Shaft Load[3] (Centered 1" from mounting face)	lbs (N)	53 (235)	53 (235)	56 (249)	56 (249)
ELECTRICAL					
Servodrive Model Number	SAC-	F03/A03	F03/B03	F06/A04	F06/B04
Torque Sensitivity, K_t	lbs-in/amp (N-m/amp)	7.16 (0.810)	7.16 (0.810)	7.5 (0.848)	7.5 (0.848)
Continuous Current	amps	3.0	3.0	5.3	5.3
Peak Current (2 seconds)	amps	6.0	6.0	12.0	12.0
Servodrive Weight	lbs (kg)	6.5 (3.0)	6.5 (3.0)	7.5 (3.4)	7.5 (3.4)
THERMAL					
Ambient Temperature	deg. C	40	40	40	40
Thermal Time Constant	minutes	18	18	20	20
Insulation Class		H	H	H	H
RESOLVER & TACH					
Quadrature Output Resolution[4]	linecount	4096	1024	4096	1024
Tachometer sensitivity	volts/Krpm	2.5	2.1	2.5	2.2

[1] Ratings are obtained with Servomotor ambient temperature at 40°C. Refer to the Servodrive Output Specifications section of this chapter to determine continuous current (torque) for operation in ambient temperatures between 0°C and 55°C, and/or 50 Hz.

[2] Maximum motor speed is determined by both the maximum speed rating of the motor and the servodrive resolver R/D circuitry. The Servodrive parameter indicates which servodrive is to be used with a motor at the specified max. speed.

[3] Shaft loads may be both radial and axial, such that **RADIAL + 2 * AXIAL < Maximum Shaft Load**.

[4] Effective encoder resolution is four times the stated linecount for motion controllers which decode every edge of the "A" and "B" quadrature encoder channels.

MAC-F Series Servomotor Specifications

PERFORMANCE[1]	Units	F060A	F060B	F115A	F115B	F115C
Maximum Speed[2]	RPM	3,000	5,000	2,500	5,000	1,500
Continuous Stall Torque	lb-in	62	58	118	116	115
	(N-m)	(7.00)	(6.50)	(13.3)	(13.1)	(13.0)
Rated Torque at Max. Speed	lb-in	61	48	113	92	113
	(N-m)	(6.88)	(5.41)	(12.82)	(10.40)	(12.82)
Rated Power at Max. Speed	HP	2.9	3.8	4.5	7.3	2.7
	watts	2,200	2,800	3,400	5,400	2,000
Peak Torque	lb-in	117	111	228	230	224
	(N-m)	(13.2)	(12.5)	(25.8)	(26.0)	(25.4)
Continuous Stall Torque/Inertia	rad/sec^2	21,849	20,168	20,248	20,041	19,835
MECHANICAL						
Moment of Inertia	lb-in-sec^{2}x10^{-3}	2.86	2.86	5.81	5.81	5.81
	(kg-m^{2}x10^{-4})	(2.23)	(3.23)	(6.56)	(6.56)	(6.56)
Friction Torque, static	lb-in	2.2	2.2	2.3	2.3	2.3
	(N-m)	(0.24)	(0.24)	(0.26)	(0.26)	(0.26)
Servomotor Weight	lbs	18.5	18.5	27.5	27.5	27.5
	(kg)	(8.4)	(8.4)	(12.5)	(12.5)	(12.5)
Mounting Bolt Diameter	inches	5.118	5.118	5.118	5.118	5.118
	(mm)	(130)	(130)	(130)	(130)	(130)
Pilot Diameter	inches	4.331	4.331	4.331	4.331	4.331
	(mm)	(110)	(110)	(110)	(110)	(110)
Shaft Diameter	inches	0.945	0.945	0.945	0.945	0.945
	(mm)	(24)	(24)	(24)	(24)	(24)
Length, mounting face to rear	inches	9.7	9.7	11.8	11.8	11.8
	(mm)	(245)	(245)	(298)	(298)	(298)
Maximum Shaft Load[3]	lbs	85	85	90	90	90
(Centered 1" from mounting face)	(N)	(378)	(378.1)	(400)	(400)	(400)
ELECTRICAL						
Servodrive Model Number	SAC-	F06/A05	F10/B06	F10/A07	F20/B08	F06/A09
Torque Sensitivity, K_t	lbs-in/amp	9.53	5.52	11.9	5.88	20.4
	(N-m/amp)	(1.077)	(0.723)	(1.34)	(0.660)	(2.31)
Continuous Current	amps	6.4	9.8	9.9	19.8	6.0
Peak Current (2 seconds)	amps	12	20	20.0	40.0	12.0
Servodrive Weight	lbs	7.5	10.5	10.5	14.5	7.5
	(kg)	(3.4)	(4.8)	(4.8)	(6.6)	(3.4)
THERMAL						
Ambient Temperature	deg. C	40	40	40	40	40
Thermal Time Constant	minutes	22	22	25	25	25
Insulation Class		H	H	H	H	H
RESOLVER & TACH						
Quadrature Output Resolution[4]	linecount	4096	1024	4096	1024	4096
Tachometer sensitivity	volts/Krpm	2.7	1.6	3.2	1.6	5.3

[1] Ratings are obtained with Servomotor ambient temperature at 40°C. Refer to the Servodrive Output Specifications section of this chapter to determine continuous current (torque) for operation in ambient temperatures between 0°C and 55°C, and/or 50 Hz.

[2] Maximum motor speed is determined by both the maximum speed rating of the motor and the servodrive resolver R/D circuitry. The Servodrive parameter indicates which servodrive is to be used with a motor at the specified max. speed.

[3] Shaft loads may be both radial and axial, such that **RADIAL + 2 * AXIAL < Maximum Shaft Load**.

[4] Effective encoder resolution is four times the stated linecount for motion controllers which decode every edge of the "A" and "B" quadrature encoder channels.

MAC-F Series Servomotor Specifications

PERFORMANCE[1]	Units	F155A		F155C
Maximum Speed[2]	RPM	3,150	4,000	2,000
Continuous Stall Torque	lb-in (N-m)	154 (17.4)	154 (17.4)	156 (17.6)
Rated Torque at Max. Speed	lb-in (N-m)	121 (13.71)	121 (13.71)	139 (15.67)
Rated Power at Max. Speed	HP	6.1	7.7	4.4
	watts	4,500	5,700	3,300
Peak Torque	lb-in (N-m)	274 (30.9)	274 (30.9)	282 (31.9)
Continuous Stall Torque/Inertia	rad/sec^2	16,887	16,887	17,150
MECHANICAL				
Moment of Inertia	$lb\text{-}in\text{-}sec^2 x10^{-3}$ $(kg\text{-}m^2 x10^{-4})$	9.1 (10.3)	9.1 (10.3)	9.2 (10.3)
Friction Torque, static	lb-in (N-m)	4.3 (0.49)	4.3 (0.49)	4.3 (0.49)
Servomotor Weight	lbs (kg)	37.0 (16.8)	37.0 (16.8)	37.0 (16.8)
Mounting Bolt Diameter	inches (mm)	6.496 (165)	6.496 (165)	6.496 (165)
Pilot Diameter	inches (mm)	5.118 (130)	5.118 (130)	5.118 (130)
Shaft Diameter	inches (mm)	0.945 (24)	0.945 (24)	0.945 (24)
Length, mounting face to rear	inches (mm)	11.0 (279)	11.0 (279)	11.0 (279)
Maximum Shaft Load[3] (Centered 1" from mounting face)	lbs (N)	153 (680)	153 (680)	153 (680)
ELECTRICAL				
Servodrive Model Number	SAC-	F20/A10	F20/B10	F10/A11
Torque Sensitivity, K_t	lbs-in/amp (N-m/amp)	7.55 (0.85)	7.55 (0.85)	15.6 (1.77)
Continuous Current	amps	20.0	20.0	10.0
Peak Current (2 seconds)	amps	40.0	40.0	20.0
Servodrive Weight	lbs (kg)	14.5 (6.59)	14.5 (6.59)	10.5 (4.8)
THERMAL				
Ambient Temperature	deg. C	40	40	40
Thermal Time Constant	minutes	28	28	28
Insulation Class		H	H	H
RESOLVER & TACH				
Quadrature Output Resolution[4]	linecount	4096	1024	4096
Tachometer sensitivity	volts/Krpm	2.5	2.0	4.0

[1] Ratings are obtained with Servomotor ambient temperature at 40°C. Refer to the Servodrive Output Specifications section of this chapter to determine continuous current (torque) for operation in ambient temperatures between 0°C and 55°C, and/or 50 Hz.

[2] Maximum motor speed is determined by both the maximum speed rating of the motor and the servodrive resolver R/D circuitry. The Servodrive parameter indicates which servodrive is to be used with a motor at the specified max. speed.

[3] Shaft loads may be both radial and axial, such that **RADIAL + 2 * AXIAL < Maximum Shaft Load**.

[4] Effective encoder resolution is four times the stated linecount for motion controllers which decode every edge of the "A" and "B" quadrature encoder channels.

MAC-F Series Servomotor Specifications

PERFORMANCE[1]	Units	F265A	F265B	F265C
Maximum Speed[2]	RPM	3,150	4,300	2,150
Continuous Stall Torque	lb-in (N-m)	266 (30.1)	276 (31.2)	266 (30.1)
Rated Torque at Max. Speed	lb-in (N-m)	240 (27.13)	191 (21.53)	235 (26.50)
Rated Power at Max. Speed	HP	12.0	13.0	8.0
	watts	9,000	9,700	6,000
Peak Torque	lb-in (N-m)	563 (63.7)	547 (61.8)	554 (62.6)
Continuous Stall Torque/Inertia	rad/sec^2	14,800	15,333	14,800
MECHANICAL				
Moment of Inertia	$lb\text{-}in\text{-}sec^2 x10^{-3}$ $(kg\text{-}m^2 x10^{-4})$	18.0 (20.34)	18.0 (20.34)	18.0 (20.34)
Friction Torque, static	lb-in (N-m)	4.56 (0.52)	4.56 (0.52)	4.56 (0.52)
Servomotor Weight	lbs (kg)	51.0 (23.1)	51.0 (23.1)	51.0 (23.1)
Mounting Bolt Diameter	inches (mm)	6.496 (130)	6.496 (130)	6.496 (130)
Pilot Diameter	inches (mm)	5.118 (130)	5.118 (130)	5.118 (130)
Shaft Diameter	inches (mm)	0.945 (24)	0.945 (24)	0.945 (24)
Length, mounting face to rear	inches (mm)	13.7 (347)	13.7 (347)	13.7 (347)
Maximum Shaft Load[3] (Centered 1" from mounting face)	lbs (N)	149 (663)	149 (663)	149 (663)
ELECTRICAL				
Servodrive Model Number	SAC-	F30/A12	F40/B13	F20/A14
Torque Sensitivity, K_t	lbs-in/amp (N-m/amp)	9.64 (1.09)	7.01 (0.792)	14.0 (1.58)
Continuous Current	amps	27.7	39.4	19.0
Peak Current (2 seconds)	amps	60.0	80.0	40.0
Servodrive Weight	lbs (kg)	21.5 (9.8)	22.0 (10.0)	14.5 (6.6)
THERMAL				
Ambient Temperature	deg. C	40	40	40
Thermal Time Constant	minutes	33	33	33
Insulation Class		H	H	H
RESOLVER & TACH				
Encoder Quadrature Resolution[4]	linecount	4096	1024	4096
Tachometer sensitivity	volts/Krpm	2.5	1.9	3.7

[1] Ratings are obtained with Servomotor ambient temperature at 40°C. Refer to the Servodrive Output Specifications section of this chapter to determine continuous current (torque) for operation in ambient temperatures between 0°C and 55°C, and/or 50 Hz.

[2] Maximum motor speed is determined by both the maximum speed rating of the motor and the servodrive resolver R/D circuitry. The Servodrive parameter indicates which servodrive is to be used with a motor at the specified max. speed.

[3] Shaft loads may be both radial and axial, such that **RADIAL + 2 * AXIAL < Maximum Shaft Load**.

[4] Effective encoder resolution is four times the stated linecount for motion controllers which decode every edge of the "A" and "B" quadrature encoder channels.

MAC-F Series Servomotor Specifications

PERFORMANCE[1]	Units	F400A	F400B	F400C
Maximum Speed[2]	RPM	3,050	4,150	1,550
Continuous Stall Torque	lb-in (N-m)	396 (44.8)	396 (44.8)	396 (44.8)
Rated Torque at Max. Speed	lb-in (N-m)	310 (35.02	216 (24.37)	358 (40.43)
Rated Power at Max. Speed	HP	15.0	14.2	8.8
	watts	11,200	10,600	6,600
Peak Torque	lb-in (N-m)	680 (76.9)	780 (88.1)	798 (90.2)
Continuous Stall Torque/Inertia	rad/sec^2	14,732	14,732	14,732
MECHANICAL				
Moment of Inertia	lb-in-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	26.9 (30.4)	26.9 (30.4)	26.9 (30.4)
Friction Torque, static	lb-in (N-m)	8.3 (0.94)	8.3 (0.94)	8.3 (0.94)
Servomotor Weight	lbs (kg)	66.0 (29.9)	66.0 (29.9)	66.0 (29.9)
Mounting Bolt Diameter	inches (mm)	6.496 (130)	6.496 (130)	6.496 (130)
Pilot Diameter	inches (mm)	5.118 (130)	5.118 (130)	5.118 (130)
Shaft Diameter	inches (mm)	1.260 (32)	1.260 (32)	1.260 (32)
Length, mounting face to rear	inches (mm)	16.4 (416)	16.4 (416)	16.4 (416)
Maximum Shaft Load[3] (Centered 1" from mounting face)	lbs (N)	165 (734)	153 (680)	208 (925)
ELECTRICAL				
Servodrive Model Number	SAC-	F40/A15	F55/B16	F20/B17
Torque Sensitivity, K_t	lbs-in/amp (N-m/amp)	9.9 (1.12)	7.24 (0.82)	19.81 (2.24)
Continuous Current	amps	40.0	54.8	20.0
Peak Current (2 seconds)	amps	80.0	110.0	40.0
Servodrive Weight	lbs (kg)	22.0 (10.0)	23.0 (10.5)	14.5 (6.6)
THERMAL				
Ambient Temperature	deg. C	40	40	40
Thermal Time Constant	minutes	38	38	38
Insulation Class		H	H	H
ENCODER & TACH				
Encoder Quadrature Resolution[4]	linecount	4096	1024	4096
Tachometer sensitivity	volts/Krpm	2.6	1.9	5.2

[1] Ratings are obtained with Servomotor ambient temperature at 40°C. Refer to the Servodrive Output Specifications section of this chapter to determine continuous current (torque) for operation in ambient temperatures between 0°C and 55°C, and/or 50 Hz.

[2] Maximum motor speed is determined by both the maximum speed rating of the motor and the servodrive resolver R/D circuitry. The Servodrive parameter indicates which servodrive is to be used with a motor at the specified max. speed.

[3] Shaft loads may be both radial and axial, such that **RADIAL + 2 * AXIAL < Maximum Shaft Load**.

[4] Effective encoder resolution is four times the stated linecount for motion controllers which decode every edge of the "A" and "B" quadrature encoder channels.

MAC-F Series Servomotor Specifications

PERFORMANCE[1]	Units	F700A	F700C	F960A
Maximum Speed[2]	RPM	2,000	1,500	1,550
Continuous Stall Torque	lb-in (N-m)	696 (78.7)	696 (78.7)	960 (109)
Rated Torque at Max. Speed	lb-in (N-m)	586 (66.22)	609 (68.83)	834 (94.18)
Rated Power at Max. Speed	HP	18.6	14.5	20.5
	watts	13,900	10,800	15,300
Peak Torque	lb-in (N-m)	1560 (176)	1536 (174)	2088 (236)
Continuous Stall Torque/Inertia	rad/sec^2	9,355	9,355	8,602
MECHANICAL				
Moment of Inertia	lb-in-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	74.4 (84.0)	74.4 (84.0)	111.6 (126.0)
Friction Torque, static	lb-in (N-m)	8.0 (0.90)	8.0 (0.90)	12.2 (1.4)
Servomotor Weight	lbs (kg)	112.0 (50.6)	112.0 (50.6)	147.0 (67.0)
Mounting Bolt Diameter	inches (mm)	8.464 (215)	8.464 (215)	8.464 (215)
Pilot Diameter	inches (mm)	7.087 (180)	7.087 (180)	7.087 (180)
Shaft Diameter	inches (mm)	1.260 (32)	1.260 (32)	1.890 (48)
Length, mounting face to rear	inches (mm)	17.0 (431)	17.0 (431)	20.5 (521)
Maximum Shaft Load[3] (Centered 1" from mounting face)	lbs (N)	283 (1259)	283 (1259)	290 (1290)
ELECTRICAL				
Servodrive Model Number	SAC-	F55/A18	F40/A19	F55/B20
Torque Sensitivity, K_t	lbs-in/amp (N-m/amp)	14.6 (1.65)	19.9 (2.25)	19.6 (2.21)
Continuous Current	amps	48.0	35.5	49.1
Peak Current (2 seconds)	amps	110.0	108.5	110.0
Servodrive Weight	lbs (kg)	23.0 (10..5)	23.0 (10..5)	23.0 (10..5)
THERMAL				
Ambient Temperature	deg. C	40	40	40
Thermal Time Constant	minutes	48	48	55
Insulation Class		H	H	H
ENCODER & TACH				
Encoder Quadrature Resolution[4]	linecount	4096	4096	4096
Tachometer sensitivity	volts/Krpm	4.0	4.0	5.2

[1] Ratings are obtained with Servomotor ambient temperature at 40°C. Refer to the Servodrive Output Specifications sectio this chapter to determine continuous current (torque) for operation in ambient temperatures between 0°C and 55°C, and/o 50 Hz.

[2] Maximum motor speed is determined by both the maximum speed rating of the motor and the servodrive resolver R/D circuitry. The Servodrive parameter indicates which servodrive is to be used with a motor at the specified max. speed.

[3] Shaft loads may be both radial and axial, such that **RADIAL + 2 * AXIAL < Maximum Shaft Load**.

[4] Effective encoder resolution is four times the stated linecount for motion controllers which decode every edge of the "A" a quadrature encoder channels.

Chapter 7
Maintenance and Troubleshooting

7 Maintenance and Troubleshooting

7.1 Power Supply Status Indications

The Power Supply status indicators are a series of LEDs (depending on the model) which provide an indication of the unit's status. If any of the on-board diagnostic functions are activated, the DC Bus is disabled, the FAULT relay is opened, and the appropriate status indicator LED is lit. The control power should be maintained in case of a Power Supply fault, so that the status indicator LEDs can indicate the unit's status, until the cause of the fault is determined.

Check the cause, correct the problem, and restart operation. **Before checking the cause, turn off the control and main power circuits and wait for the Servodrive power stage capacitors to discharge fully to avoid possible electrical shock.**

Power Supply faults are reset by disabling both the main and control power, and waiting for the power stage capacitors to fully discharge before reapplying power.

Notes: If the fault is due to excessive regen resistor or Power Supply temperature, the FAULT relay will not reset until the Power Supply has cooled down. If the Power Supply is connected to an external regen resistor, and an excessive regen resistor fault occurs, the regen resistor thermal overload relay must be reset.

The regen resistor overload relay may be reset waiting for the regen resistor to cool down and pressing the reset handle on the top of the relay. Refer to Appendix A for an overload relay diagram.

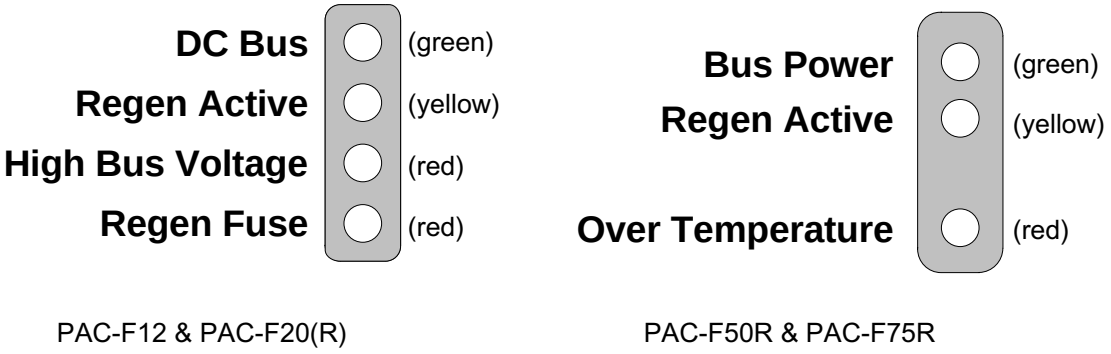


***Figure 8**, Power Supply Status LEDs*

7.1.1 PAC-F12 and PAC-F20(R) Status Indicators and Descriptions

Status Indicator	LED Color	Description
DC Bus	Green	Illuminated to indicate that main DC Bus power is on. **This is not a fault condition.**
Regen Active	Yellow	Illuminated to indicate that the Power Supply shunt regulator circuit is active. **This is not a fault condition.**
High Bus Voltage	Red	Illuminated to indicate a Power Supply High Bus Voltage fault. (approx. 430 VDC).
Regen Fuse	Red	Illuminated to indicate that the shunt regulator regen resistor fuse is blown. Refer to the Power Supply Fuses section of the Specifications chapter for replacement fuse information.

7.1.2 PAC-F50R and PAC-F75R Status Indicators and Descriptions

Status Indicator	LED Color	Description
DC Bus	Green	Illuminated to indicate that main DC Bus power is on. **This is not a fault condition.**
Regen Active	Yellow	Illuminated to indicate that the Power Supply shunt regulator circuit is active. **This is not a fault condition.**
Over Temperature	Red	Illuminated to indicate excessive Power Supply heatsink or ambient temperature fault.

7.2 Power Supply Fuse Replacement

NOTE: **Before attempting to replace Power Supply fuses, turn off the control and main power circuits and wait for the Servodrive power stage capacitors to discharge fully to avoid possible electric shock.**

Fuse protection is provided for the +/-18 VDC and +10 VDC control power, and soft-start (for PAC-F50R and F75R only) circuitry on all F-Series Power Supplies. Regen resistor fuse protection is provided for the PAC-F12 and PAC-F20(R) Power Supplies. Refer to the Power Supply Fuses section of the

Specifications chapter for fuse part number, current rating, and locator information. Refer to Appendix A Power Supply Fuse Location drawing for fuse locations.

All Power Supply fuses are located inside the Power Supply, therefore the outside cover must be removed to replace them. In the case of the PAC-F50R and F75R there are several header connectors that must be disconnected to remove the unit cover, and there are fuses on both circuit boards. Be sure to note which connector is for which header, several of the connectors similar in appearance.

7.3 Servodrive Status Indications

The Servodrive status indicators are a series of 9 LEDs which provide an indication of the Servodrive and Servomotor status. If any of the on-board diagnostic functions are activated, the output transistors are disabled, the DRV-RDY' interlock output is turned OFF, and the appropriate status indicator LED(s) will be lit. The control power should be maintained in case of a Servodrive fault, so that the status indicator LEDs can indicate the unit's status, until the cause of the fault is determined.

Check the cause, correct the problem, and restart the operation. **Before checking the cause, turn off the control and main power circuits and wait for the Servodrive power stage capacitors to discharge fully to avoid possible electrical shock.**

Notes:

1) Asserting the ALM-RESET' input will reset the Servodrive.

2) If the fault is due to an over temperature fault, the Servodrive will not reset until it's heat sink has cooled down. If an over temperature fault resets immediately, it is likely that the fault was actually due to an RMS current limit condition.

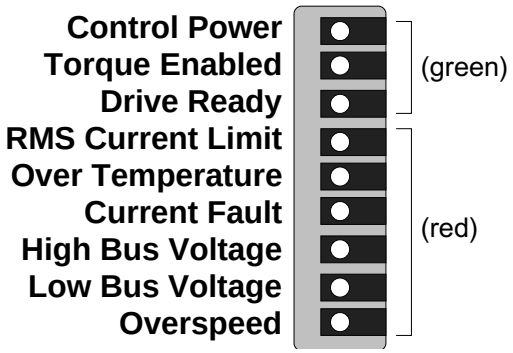


***Figure 9**, Servodrive Status LEDs*

7.3.1 Servodrive Status Indicators and Descriptions

Status Indicator	LED Color	Description
Control Power	Green	Illuminated to indicate DC Control Power is on. **This is not a fault condition.**
Torque Enabled	Green	Illuminated to indicate that the Servodrive is enabled. **This is not a fault condition.**
Drive Ready	Green	Illuminated to indicate that the Servodrive is ready for normal operation, no faults are detected. **This is not a fault condition.**
RMS Current Limit	Red	Illuminated (along with the Over Temperature LED) during a RMS current limit fault. Refer to the Over Temperature LED explanation below. (This is not a latched indicator, when the motor stops commanding current in excess of the RMS limit, this LED is unasserted)
Over Temperature	Red	Illuminated (along with the RMS Current Limit LED) to indicate an over temperature or RMS current limit fault. Refer to the RMS Current Limit LED explanation above.
Current Fault	Red	Illuminated to indicate an excessive output current fault.
High Bus Voltage	Red	Illuminated to indicate excessive main DC Bus voltage.
Low Bus Voltage	Red	Illuminated to indicate insufficient main DC Bus voltage.
Overspeed	Red	Illuminated to indicate excessive motor speed.

7.4 TC1 Servodrive Test Points

Terminal	Description	
1	Speed Monitor	Bi-directional, approx. 8.0 VDC = maximum speed. Refer to the F-Series Servomotors Specifications section of the Specifications chapter for further speed monitor scaling information.
2	Torque Monitor	Unipolar, 8.0 VDC = peak torque
3	Signal Common	Reference common for monitor signals

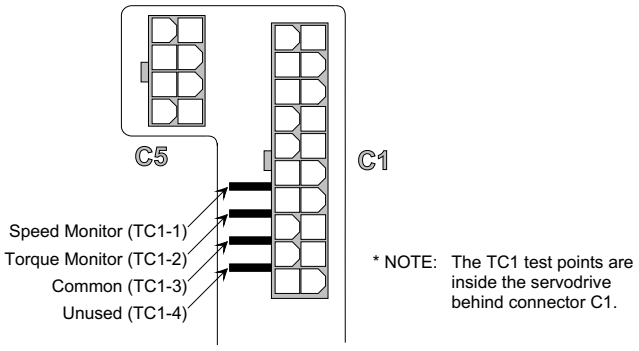


***Figure 10**, Servodrive Test Points (TC1)*

7.5 PAC-F12 and PAC-F20(R) Troubleshooting Guide

ALARM STATUS INDICATION AND TROUBLESHOOTING IDEAS

LED Indicator	Detection Condition	Probable Cause	Corrective Action
Bus Power (Not Illuminated)	When power is supplied to the main circuit or during normal operation	Main fuses blown or circuit breaker tripped	Determine and correct main input power problem, and replace fuses or reset circuit breaker
		Low or absent Main DC Bus voltage	Replace Power Supply
High Bus Voltage (Illuminated)	During normal operation	High main input voltage	Correct main input voltage
		Shunt regulator circuit overload	Reduce motor load or use a larger capacity power supply
		Defective Power Supply	Replace Power Supply
Regen Fuse (Illuminated)	During normal operation	Shunt regulator regen resistor dissipation wattage too low.	Increase regen resistor dissipation wattage and install new fuse.
			Replace regen resistor fuse and reduce regenerative load.
		Defective Power Supply	Replace Power Supply

7.6 PAC-F50R and PAC-F75R Troubleshooting Guide

ALARM STATUS INDICATION AND TROUBLESHOOTING IDEAS

LED Indicator	Detection Condition	Probable Cause	Corrective Action
Bus Power (Not Illuminated)	When power is supplied to the main circuit or during normal operation	Main fuses blown or circuit breaker tripped	Determine and correct main input power problem, and replace fuses or reset circuit breaker
		Low or absent Main DC Bus voltage	Replace Power Supply
Over Temperature (Illuminated)	During normal operation	High main input voltage	Correct main input voltage
		Shunt regulator circuit overload	Reduce motor load or use a larger capacity power supply
		Defective Power Supply	Replace Power Supply

7.7 Servodrive Troubleshooting Guide

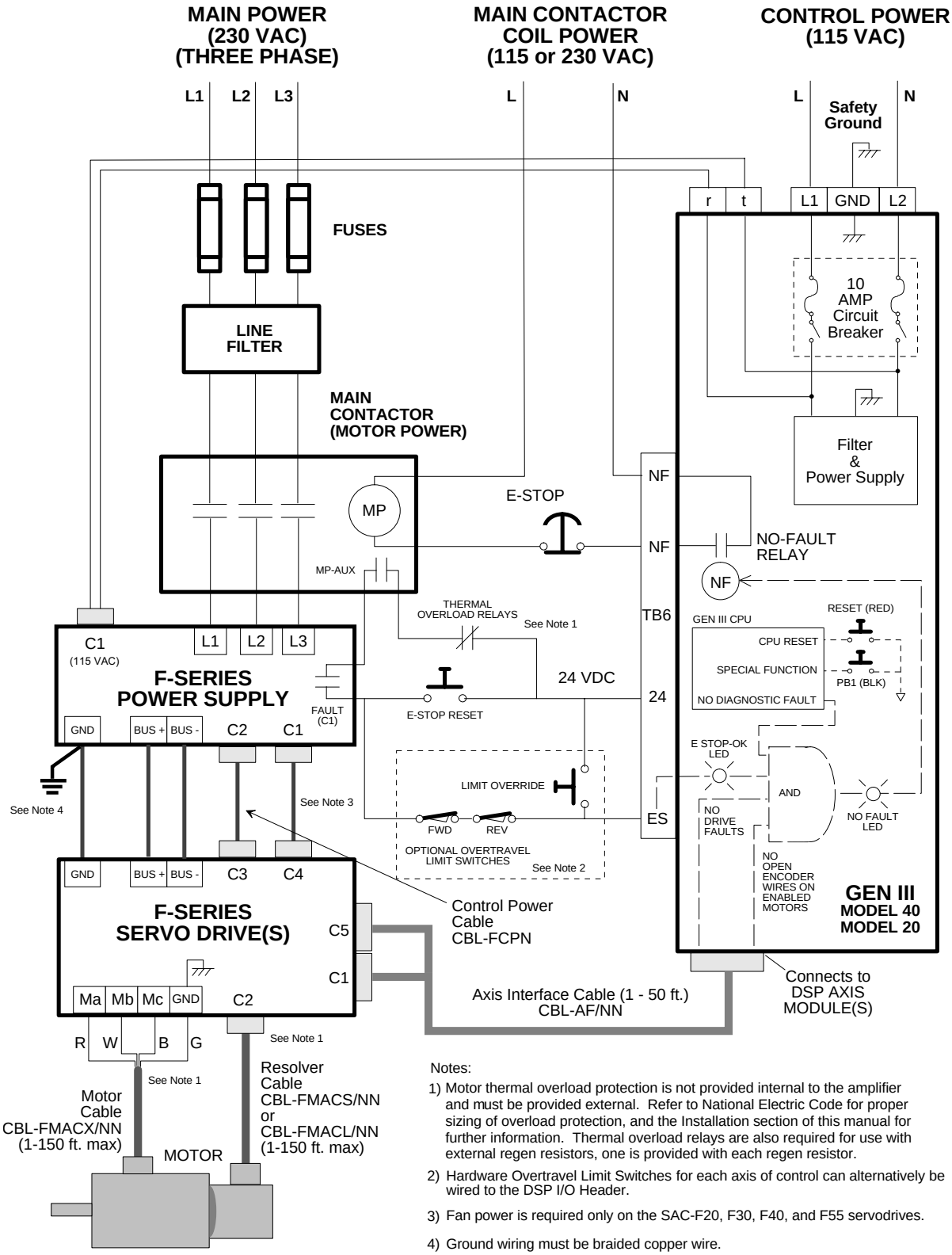
ALARM STATUS INDICATION AND TROUBLESHOOTING IDEAS

LED Indicator	Detection Condition	Probable Cause	Corrective Action
Control Power (Not Illuminated)	When power is supplied to the control circuit or during normal operation	Improper control power voltage	Correct control power voltage
		Incorrect or defective control DC Bus power wiring	Correct or replace control DC Bus wiring
		Blown Power Supply control DC Bus power fuse.	Replace Power Supply control DC Bus power fuse
		Defective Power Supply control DC Bus power supply.	Replace Power Supply
		Defective Servodrive	Replace Servodrive
Torque Enabled (Not Illuminated)	When motion controller has attempted enabled axis	Incorrect or defective interlock wiring	Correct or replace interlock wiring
		Servodrive Alarm condition	Determine cause of Alarm, correct problem, and reset Servodrive
		Defective Controller DSP Axis Module output	Replace Controller DSP Axis Module
		Defective Servodrive	Replace Servodrive

LED Indicator	Detection Condition	Probable Cause	Corrective Action
Drive Ready (Not Illuminated)	During normal operation	Servodrive Alarm condition	Determine cause of Alarm, correct problem, and reset Servodrive
	When Motion Controller has attempted to enable axis	Servomotor compensation board improperly installed	Verify Servomotor compensation board installation
		ALM-RESET' input asserted	Verify interlock wiring
		Defective Servodrive	Replace Servodrive
RMS Current Limit (Illuminated)	During normal operation (not a latched indicator)	Servodrive commanding current in excess of continuous RMS limit	Reduce motor load or duty cycle. Eliminate load jam or binding.
Over Temperature (Illuminated)	During normal operation	Excessive heatsink temperature due to overload	Reduce motor load
		Excessive ambient temperature	Reduce ambient temperature to 45°C
		RMS Current Limit	Reduce motor load or duty cycle. Eliminate load jam or binding.
	Prior to enabling the axis or during normal operation	Defective Servodrive	Replace Servodrive
Current Fault (Illuminated)	When enabling axis with Servomotor connected	Incorrect servomotor wiring	Correct servomotor wiring
		Defective Servomotor	Replace Servomotor
	After applying control power with Servomotor disconnected	Defective Servodrive	Replace Servodrive
High Bus Voltage (Illuminated)	During normal operation	Improperly sized regen resistor	Increase regen resistor dissipation wattage, or reduce motor load or duty cycle.
		Defective Servodrive	Replace Servodrive
Low Bus Voltage (Illuminated)	During normal operation	Main power disabled	Enable main power
		Defective Power Supply	Replace Power Supply
		Defective Servodrive	Replace Servodrive
Overspeed (Illuminated)	During normal operation	Excessive motor speed	Reduce commanded speed
		Incorrect or defective Servomotor resolver wiring	Correct or replace Servomotor resolver wiring

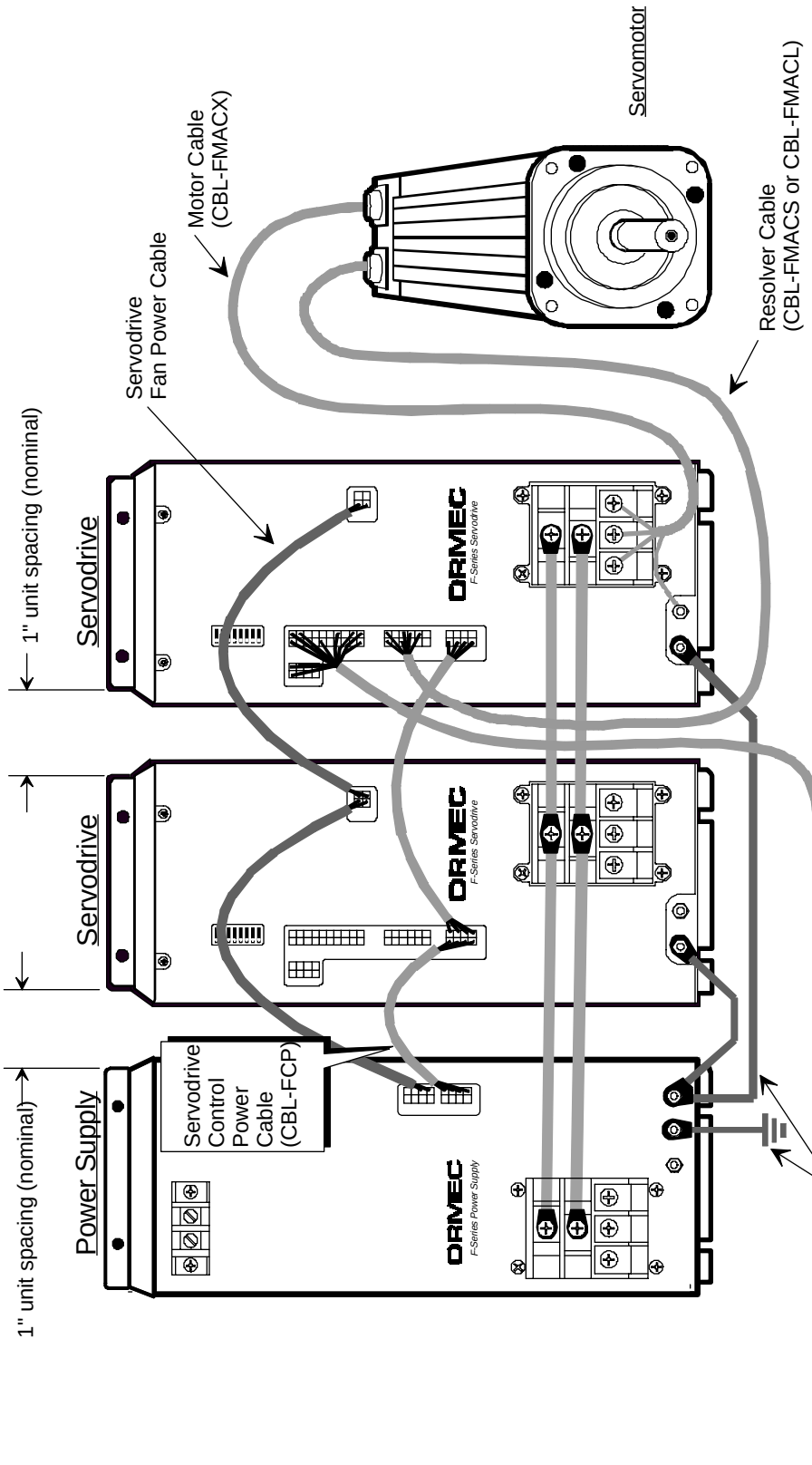
7.8 Servomotor Troubleshooting Guide

Problem	Cause	What to do
Motor does not start	Loose Connection	Tighten connection
	Wrong wiring	Correct wiring
	Overload	Reduce load or use a larger motor
	Motor defective	Measure voltage across motor terminals Ma, Mb, & Mc on the Servodrive with a tester. If correct voltage levels (approx. 230 VAC), replace motor, otherwise replace servodrive.
	Servodrive Defective	
Unstable Operation	Wrong Wiring	Inspect and correct wiring of motor terminals Ma, Mb, & Mc and/or the resolver.
Motor Overheats	Excessive ambient temperature	Reduce ambient temperature below 40°C, or use a larger motor.
	Motor dirty	Clean motor surface
	Overload	Reduce load or use a larger motor.
Unusual Noise	Motor loosely mounted	Tighten mounting bolts
	Motor misaligned	Realign
	Coupling out of balance	Balance coupling
	Noisy bearing	Check alignment, loading of bearing, lubrication.
	Vibration of driven machine	Check the machine's mechanical operation.
	Improper grounding and/or shielding	Check the servomotor, servodrive, and power supply grounding and shielding.
	Incorrect servo control loop tuning	Check the servo control loop tuning parameters.
WARNING!!! **Turn off power before working on the Servomotor**		



Notes:

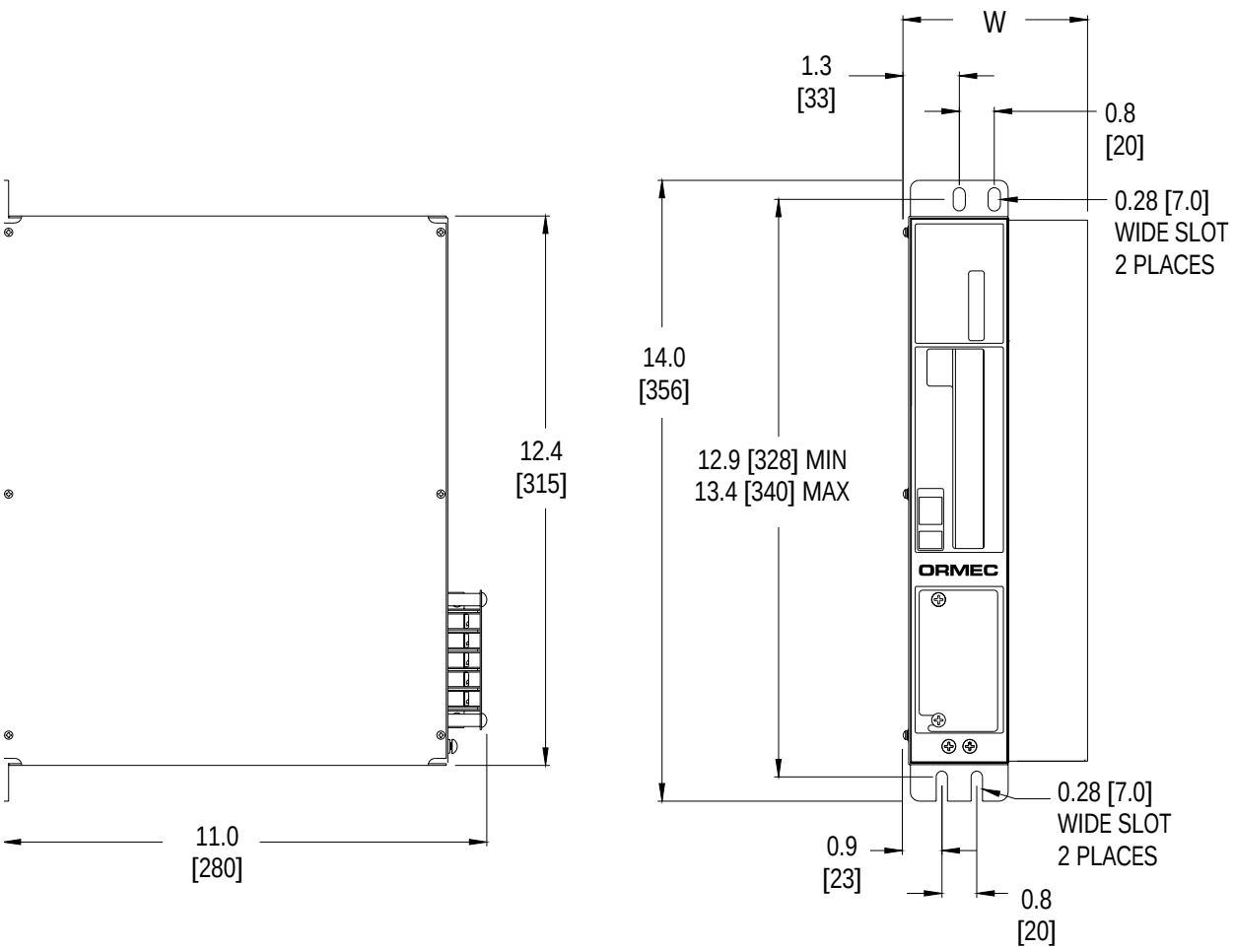
1) Motor thermal overload protection is not provided internal to the amplifier and must be provided external. Refer to National Electric Code for proper sizing of overload protection, and the Installation section of this manual for further information. Thermal overload relays are also required for use with external regen resistors, one is provided with each regen resistor.
2) Hardware Overtravel Limit Switches for each axis of control can alternatively be wired to the DSP I/O Header.
3) Fan power is required only on the SAC-F20, F30, F40, and F55 servodrives.
4) Ground wiring must be braided copper wire.



Multi-Axis System Bus Wiring and Cabling

Servodrive Layout

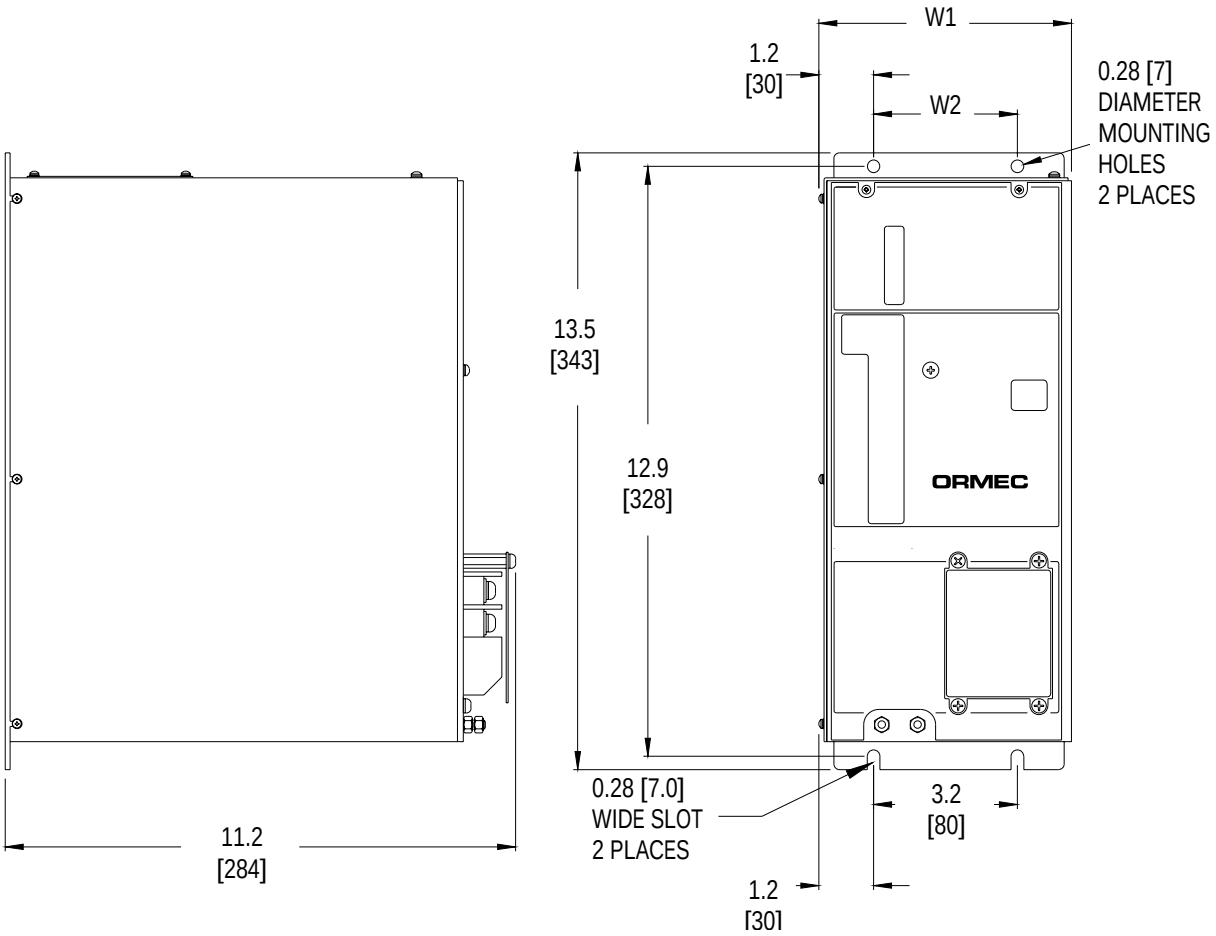
SAC-F03, SAC-F06, SAC-F10, SAC-F20



	W	
Servodrive	(inches)	(mm)
SAC-F03	2.4	60
SAC-F06	2.4	60
SAC-F10	3.5	88
SAC-F20(R)	4.2	106

Servodrive Layout

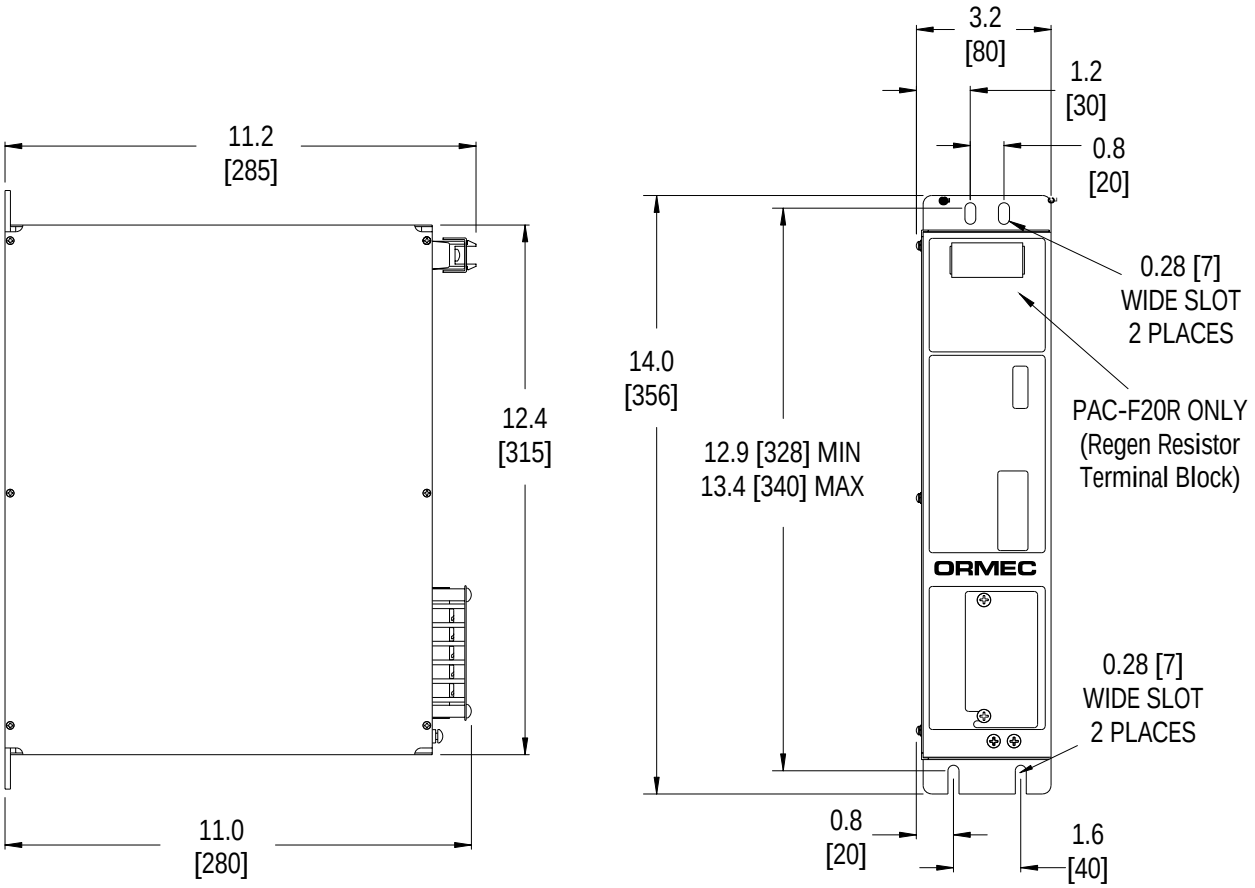
SAC-F30, SAC-F40, SAC-F55



	W1		W2	
Servodrive	(inches)	(mm)	(inches)	(mm)
SAC-F30	5.5	140	3.2	80
SAC-F40	5.5	140	3.2	80
SAC-F55	6.3	160	4	100

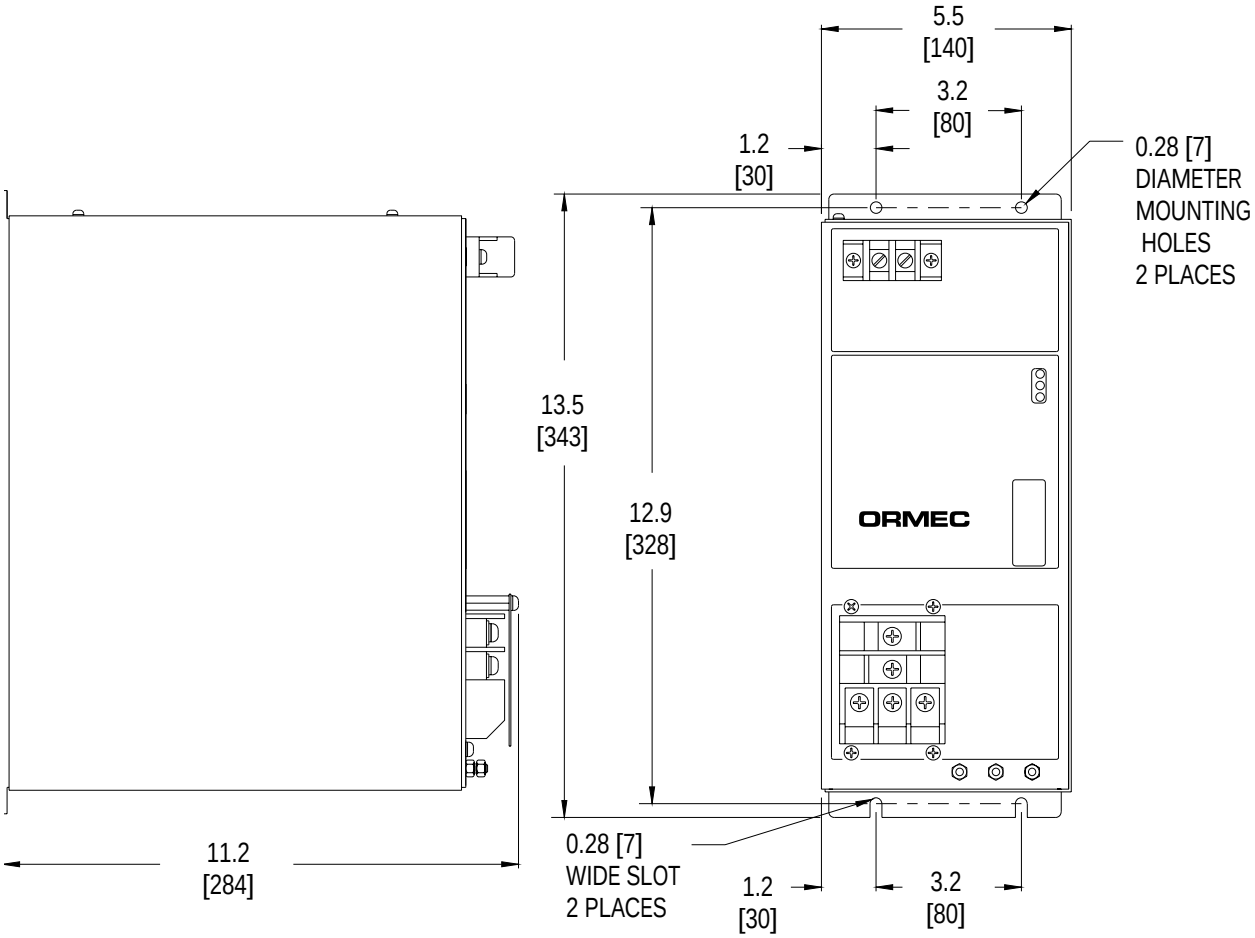
Power Supply Layout

PAC-F12, PAC-F20, PAC-F20R



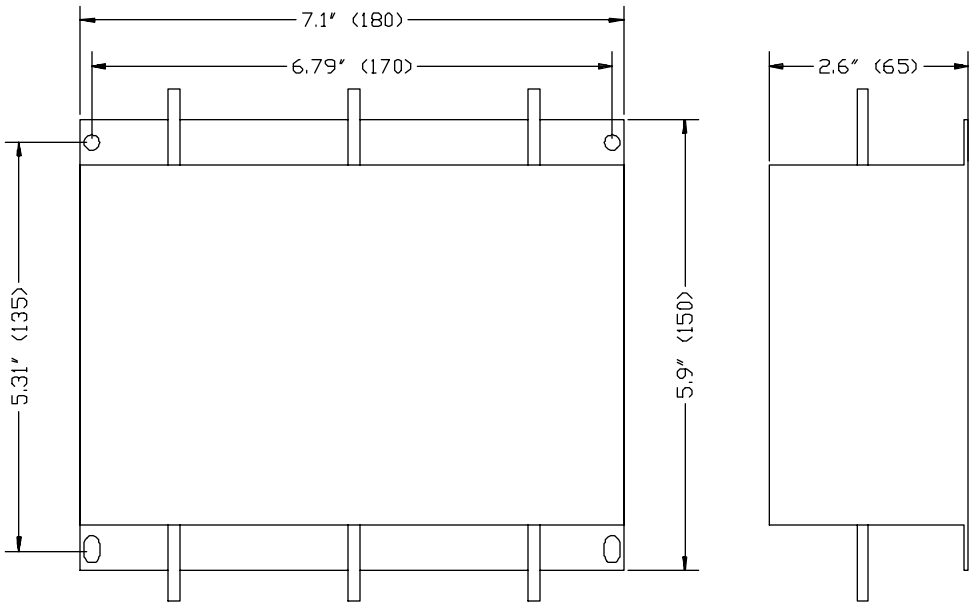
Power Supply Layout

PAC-F50R, PAC-F75R

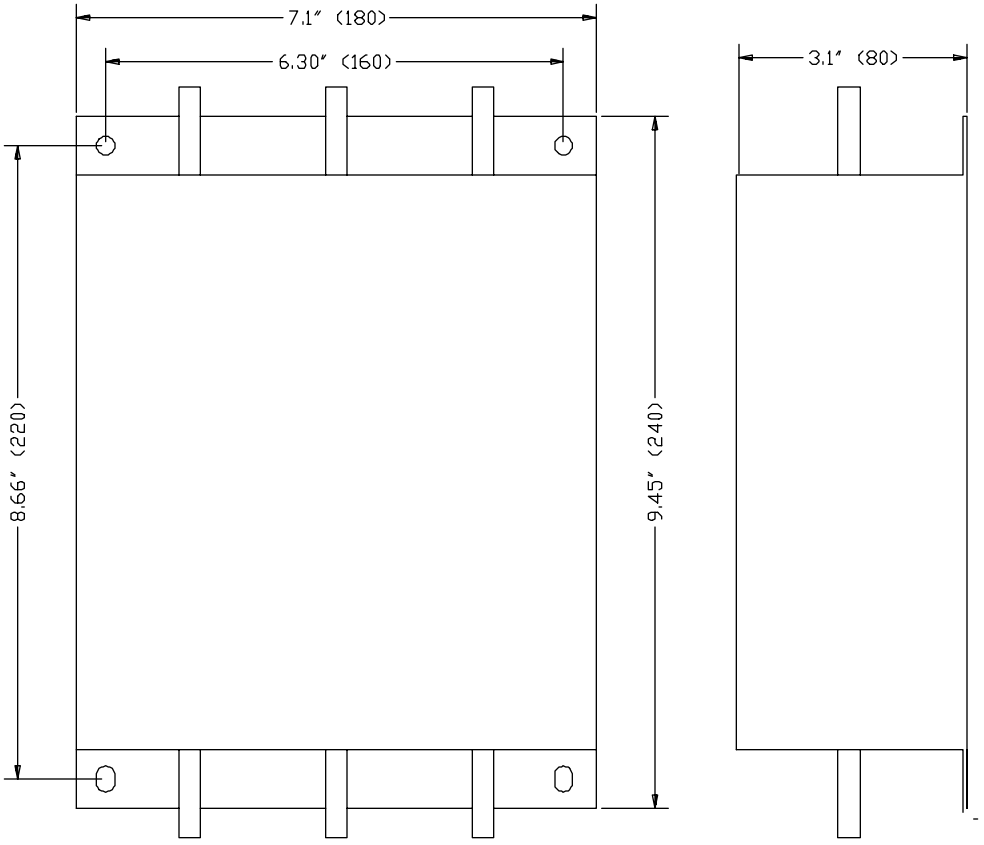


Line Filter Layout

SAC-LF10, SAC-LF30

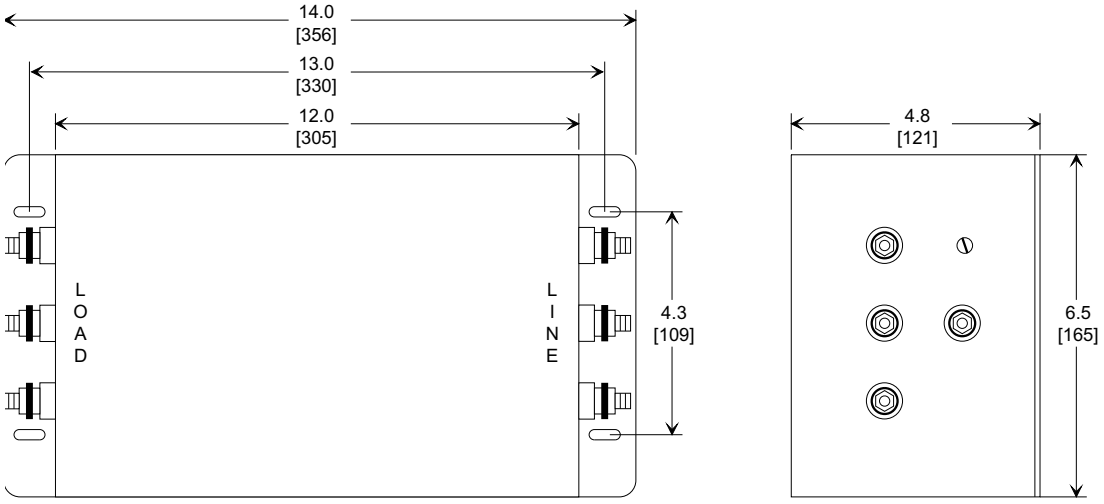


SAC-LF40, SAC-LF50



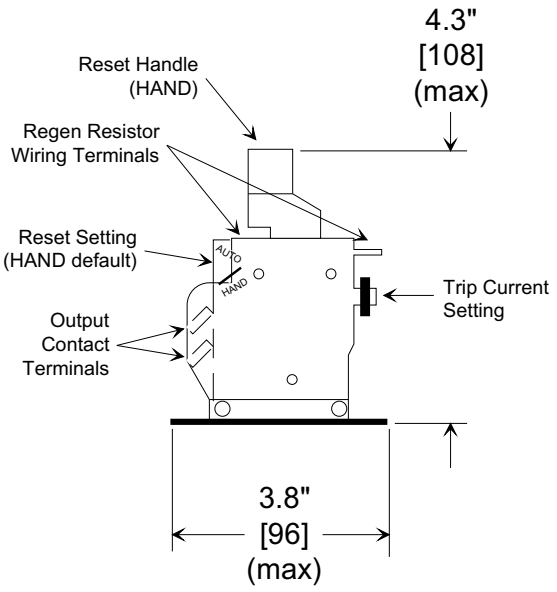
Line Filter Layout

SAC-LF100

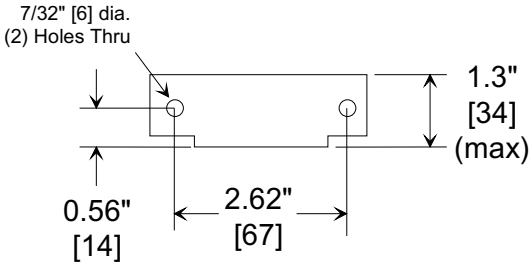


TOP VIEW END VIEW

Regen Resistor Overload Relay Layout

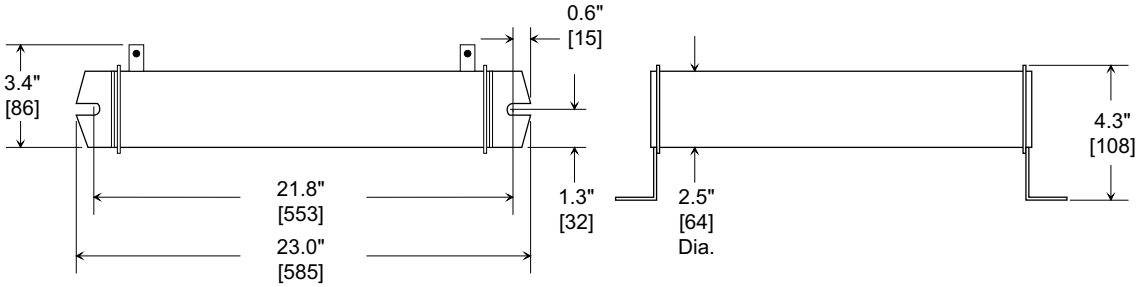


Side View

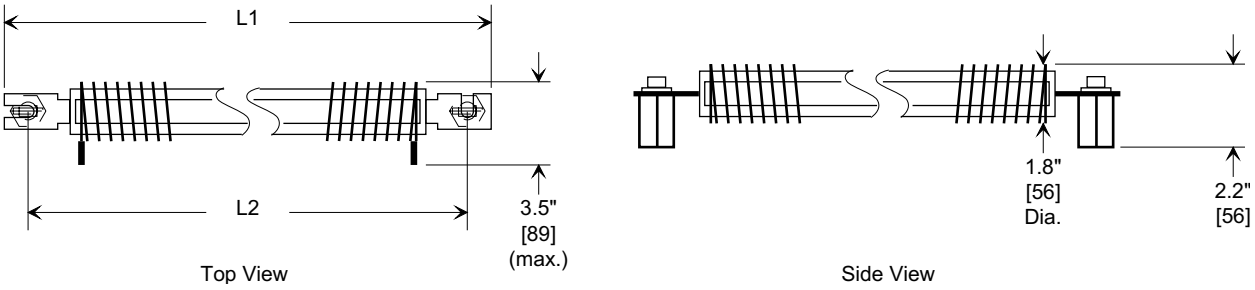


Mounting Footprint

Regen Resistor Layout
SAC-FRR/0700

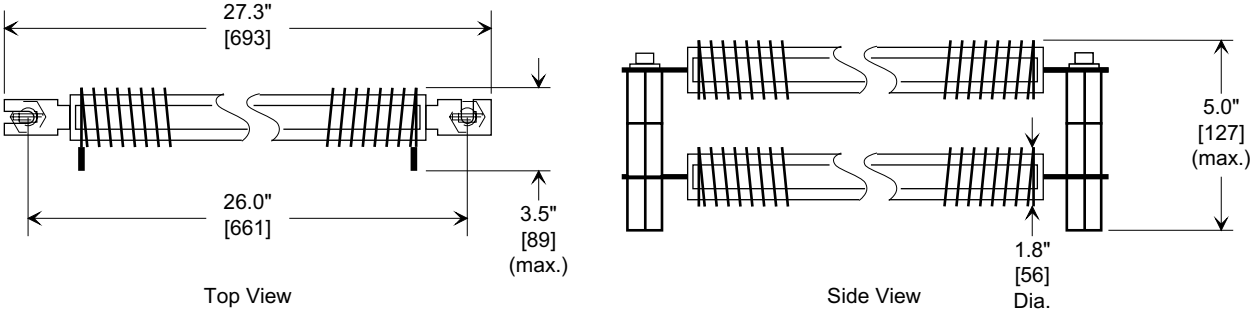


Regen Resistor Layout
SAC-FRR/0500, SAC-FRR/1000



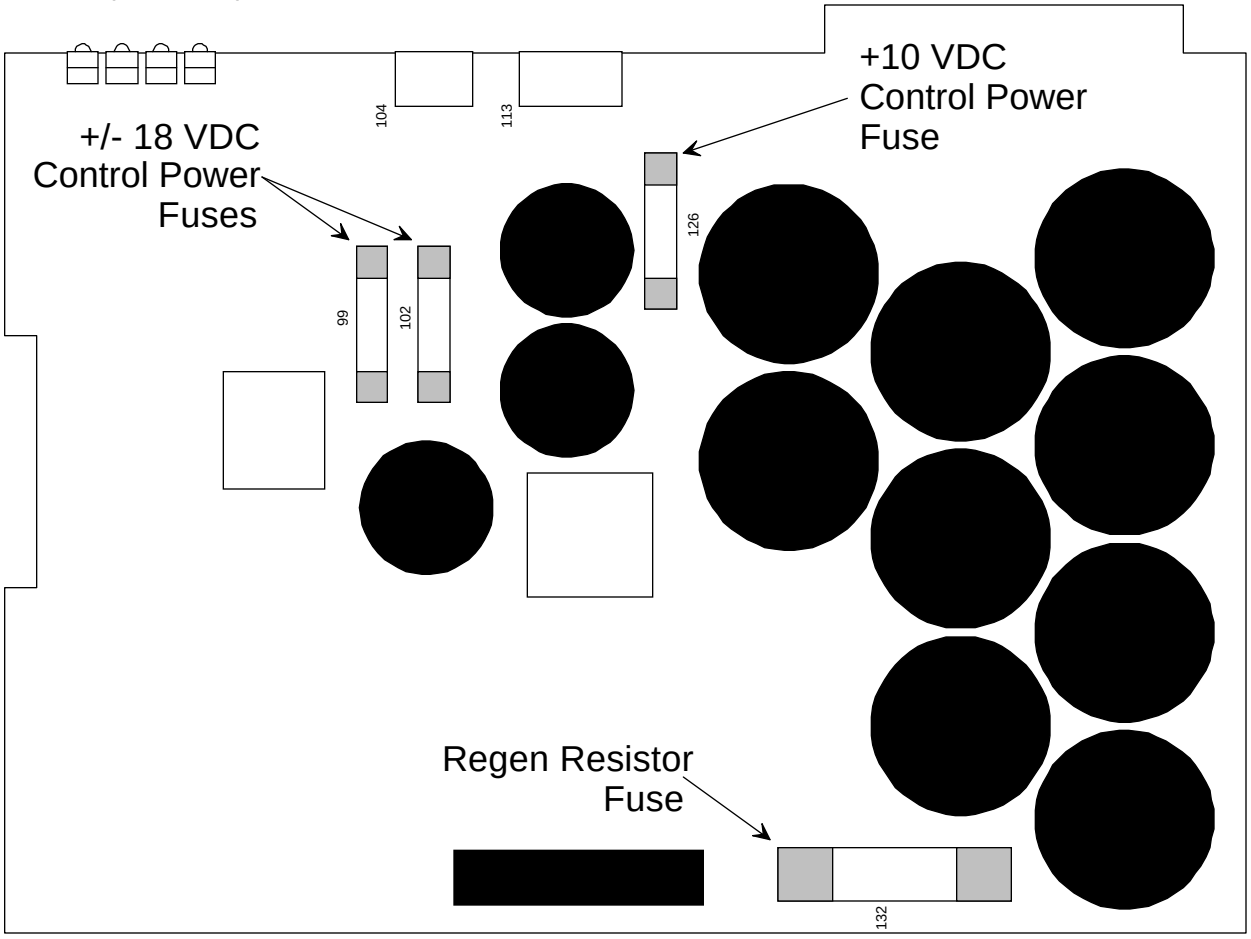
Regen Resistor	L1 (max.)	L2
SAC-FRR/0500	17.9"[455 mm]	16.3" [413 mm]
SAC-FRR/1000	27.3" [693 mm]	26.0" [661 mm]

Regen Resistor Layout
SAC-FRR/2000

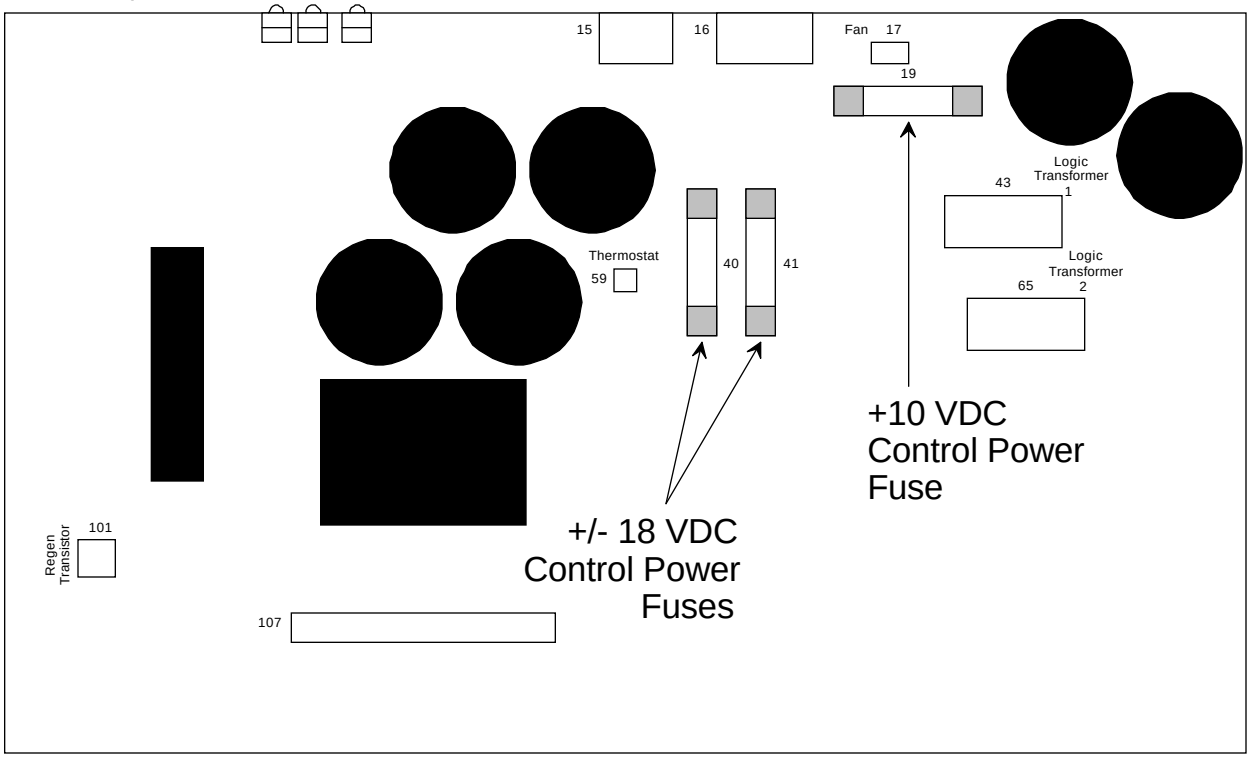


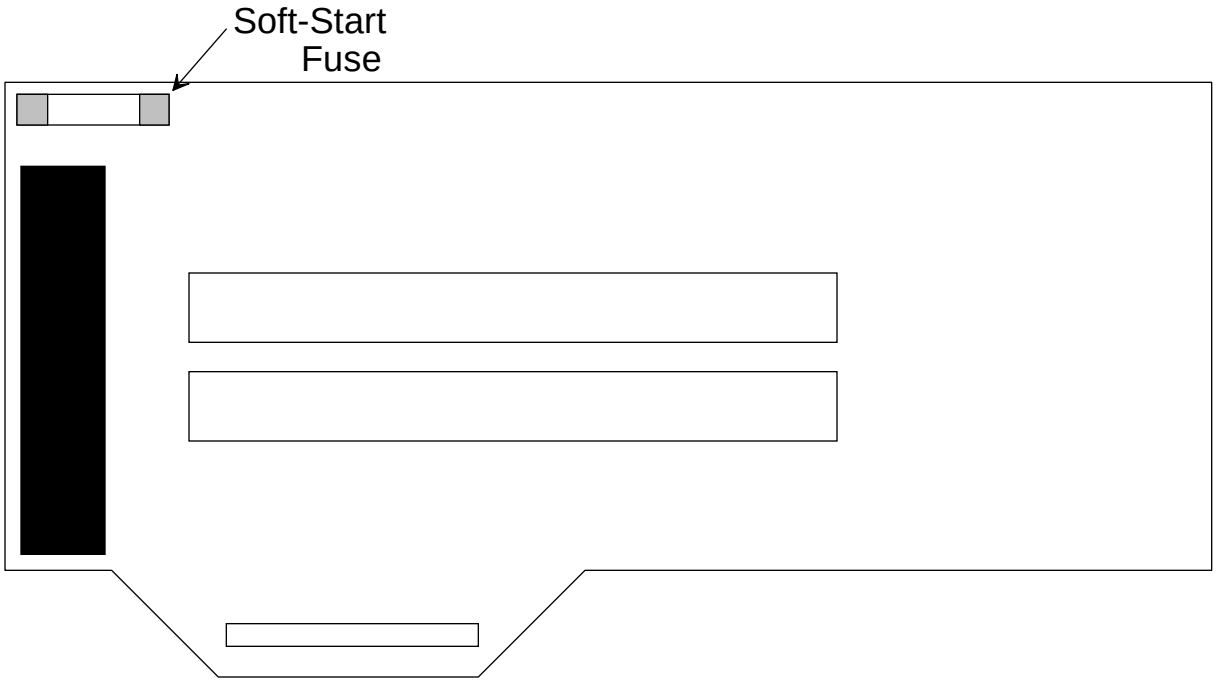
Power Supply Fuse Locations

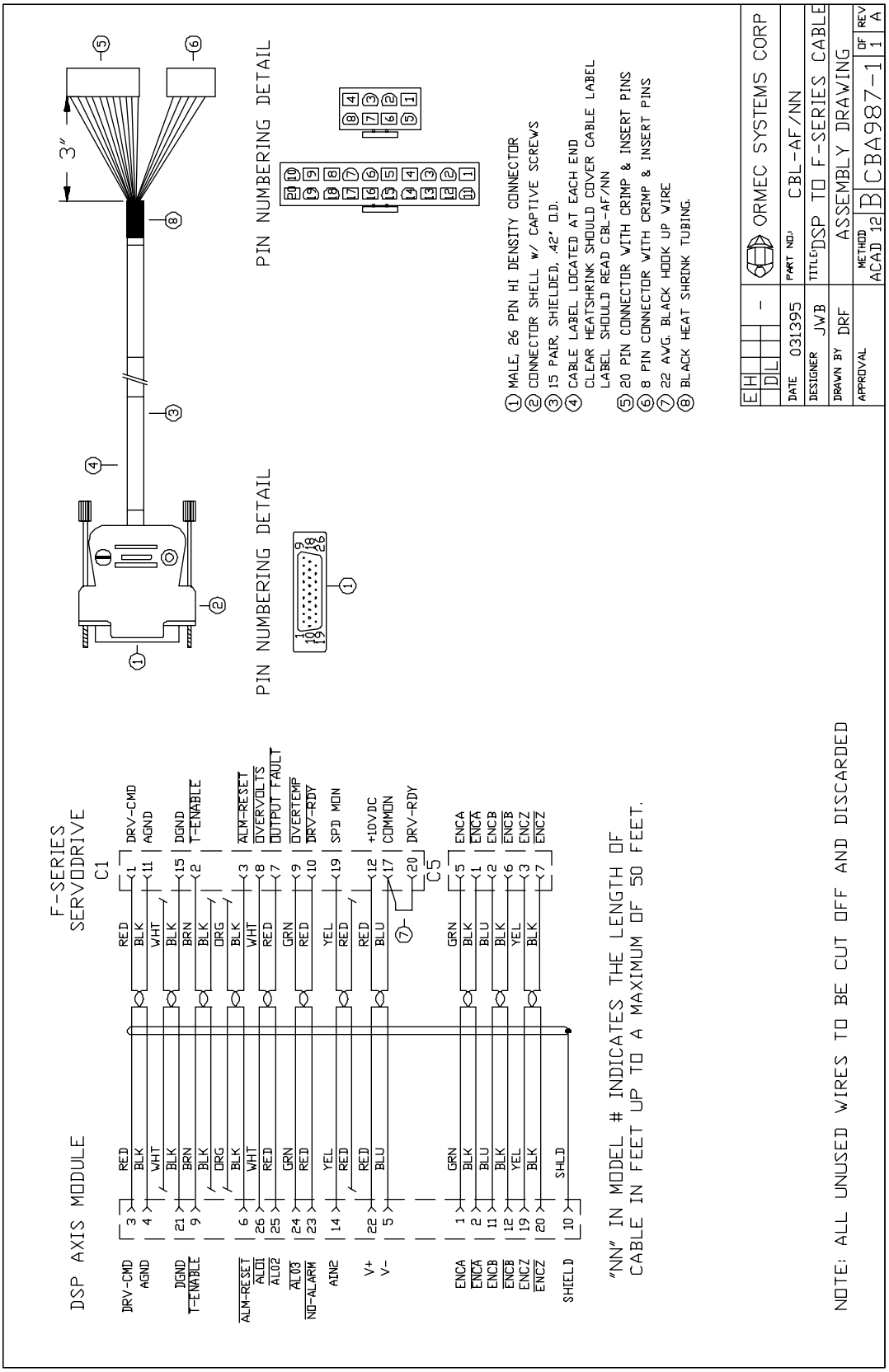
PAC-F12, PAC-F20, PAC-F20R

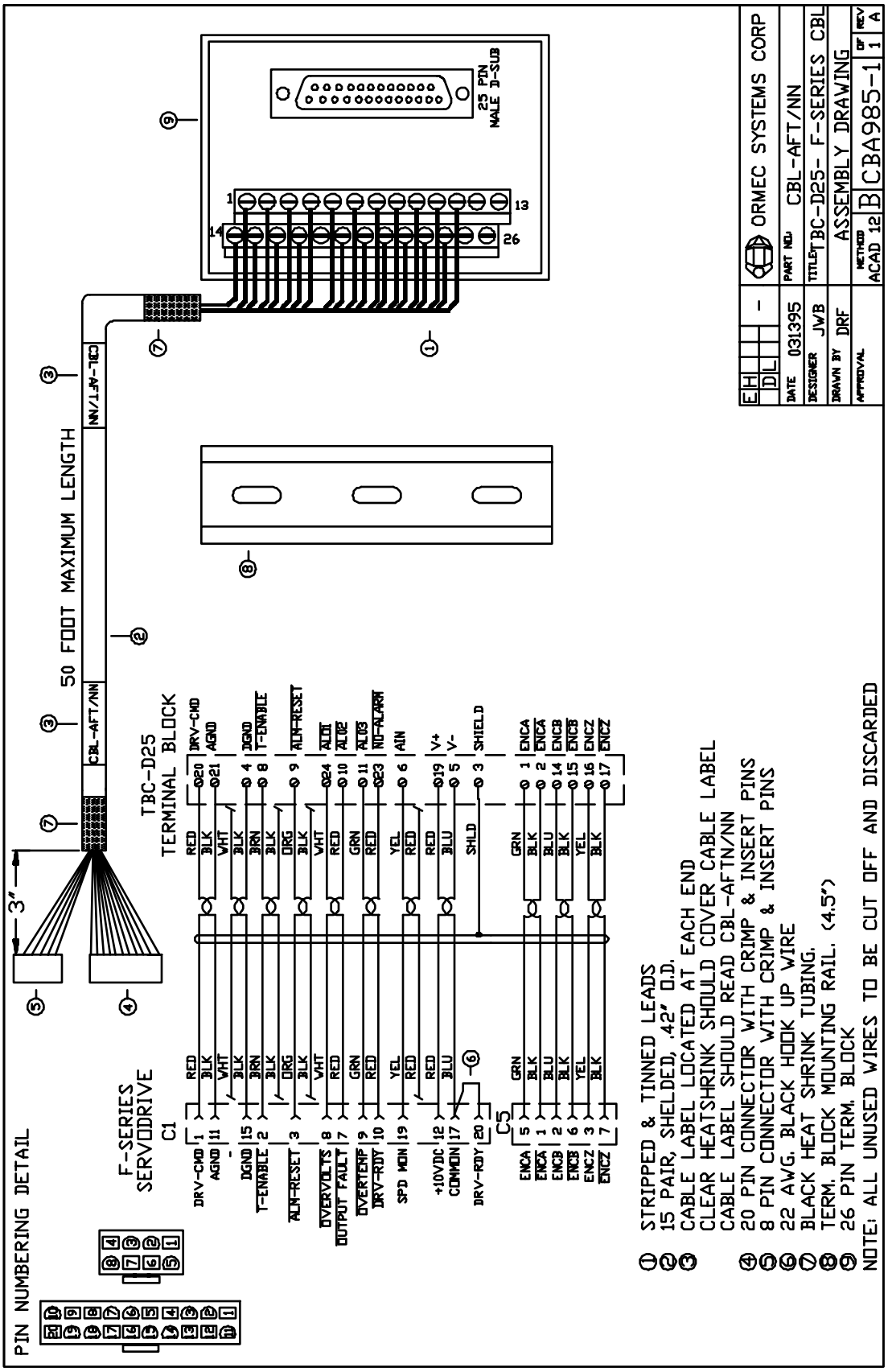


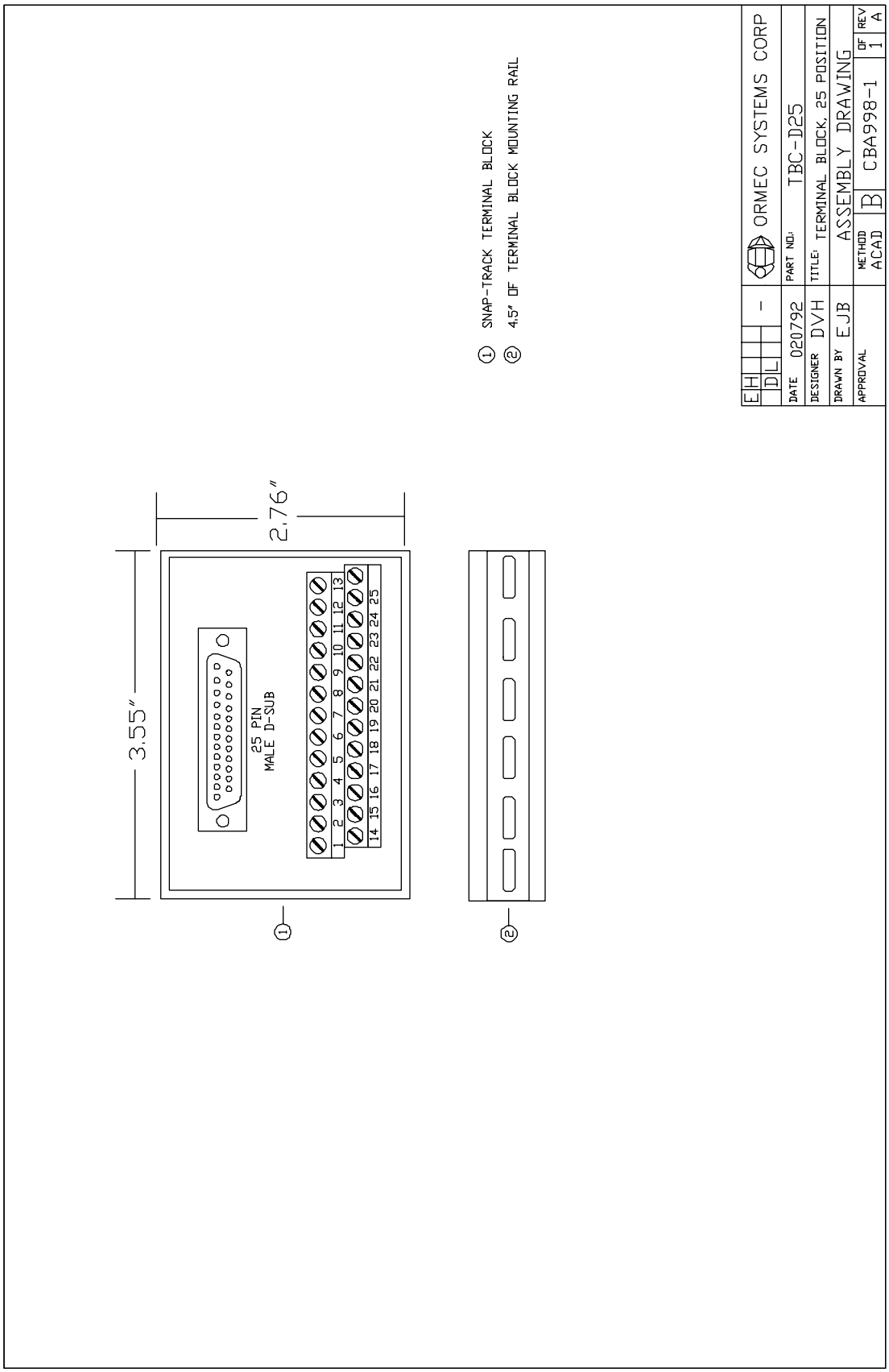
PAC-F50R, PAC-F75R






DSP AXIS MODULE
F-SERIES SERVODRIVE
C1
C5
DRV-CMD
AGND
DGND
T-ENABLE
ALM-RESET
ALDI
ALO2
ALO3
ND-ALARM
AIN2
V+
V-
SHIELD
ENCA
ENCA
ENCB
ENCB
ENCZ
ENCZ
+10VDC
COMMON
DRV-RDY
SPD MON
OVERTEMP
OVERVOLTS
OUTPUT FAULT
PIN NUMBERING DETAIL
PIN NUMBERING DETAIL
3"
"NN" IN MODEL # INDICATES THE LENGTH OF CABLE IN FEET UP TO A MAXIMUM OF 50 FEET.
NOTE: ALL UNUSED WIRES TO BE CUT OFF AND DISCARDED
1 MALE, 26 PIN HI DENSITY CONNECTOR
2 CONNECTOR SHELL W/ CAPTIVE SCREWS
3 15 PAIR, SHIELDED, .42" O.D.
4 CABLE LABEL LOCATED AT EACH END
CLEAR HEATSHRINK SHOULD COVER CABLE LABEL
LABEL SHOULD READ CBL-AF/NN
5 20 PIN CONNECTOR WITH CRIMP & INSERT PINS
6 8 PIN CONNECTOR WITH CRIMP & INSERT PINS
7 22 AWG. BLACK HOOK UP WIRE
8 BLACK HEAT SHRINK TUBING.
ORMEC SYSTEMS CORP
PART NO. CBL-AF/NN
TITLE DSP TO F-SERIES CABLE
ASSEMBLY DRAWING
DATE 031395
DESIGNER JWB
DRAWN BY DRF
APPROVAL
METHOD ACAD 12
B CBA987-1
REV A
DF 1


PIN NUMBERING DETAIL
F-SERIES SERVODRIVE C1
TBC-D25 TERMINAL BLOCK
C5
50 FOOT MAXIMUM LENGTH
CBL-AFT/NN
3"
25 PIN MALE D-SUB
DRV-CMD
AGND
DGND
T-ENABLE
ALM-RESET
OVERVOLTS
OUTPUT FAULT
OVERTEMP
DRV-RDY
SPD MON
+10VDC
COMMON
DRV-RDY
ENCA
ENCA
ENCB
ENCB
ENCZ
ENCZ
V+
V-
SHIELD
ND-ALARM
AIN
AOUT
AOUT2
AOUT3
1 STRIPPED & TINNED LEADS
2 3 15 PAIR, SHELDED, .42" O.D.
CABLE LABEL LOCATED AT EACH END
CLEAR HEATSHRINK SHOULD COVER CABLE LABEL
CABLE LABEL SHOULD READ CBL-AFTN/NN
4 5 6 7 8 20 PIN CONNECTOR WITH CRIMP & INSERT PINS
8 PIN CONNECTOR WITH CRIMP & INSERT PINS
22 AWG. BLACK HOOK UP WIRE
BLACK HEAT SHRINK TUBING.
9 TERM. BLOCK MOUNTING RAIL. (4.5")
26 PIN TERM. BLOCK
NOTE: ALL UNUSED WIRES TO BE CUT OFF AND DISCARDED
ORMEC SYSTEMS CORP
PART NO. CBL-AFT/NN
TITLE BC-D25- F-SERIES CBL
ASSEMBLY DRAWING
DESIGNER JWB
DRAWN BY DRF
DATE 031395
METHOD ACAD 12
CBA985-1
SIZE B
REV A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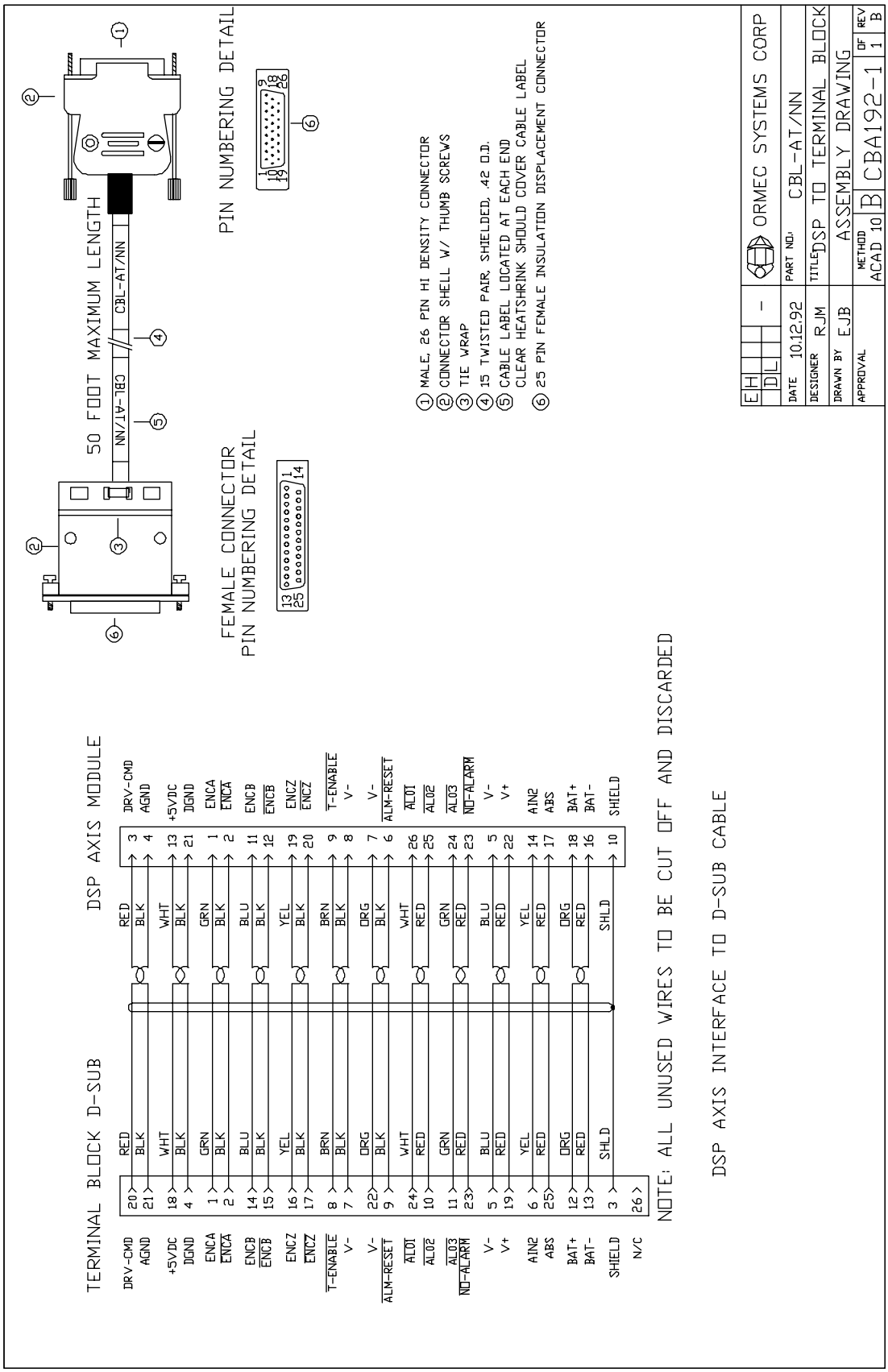
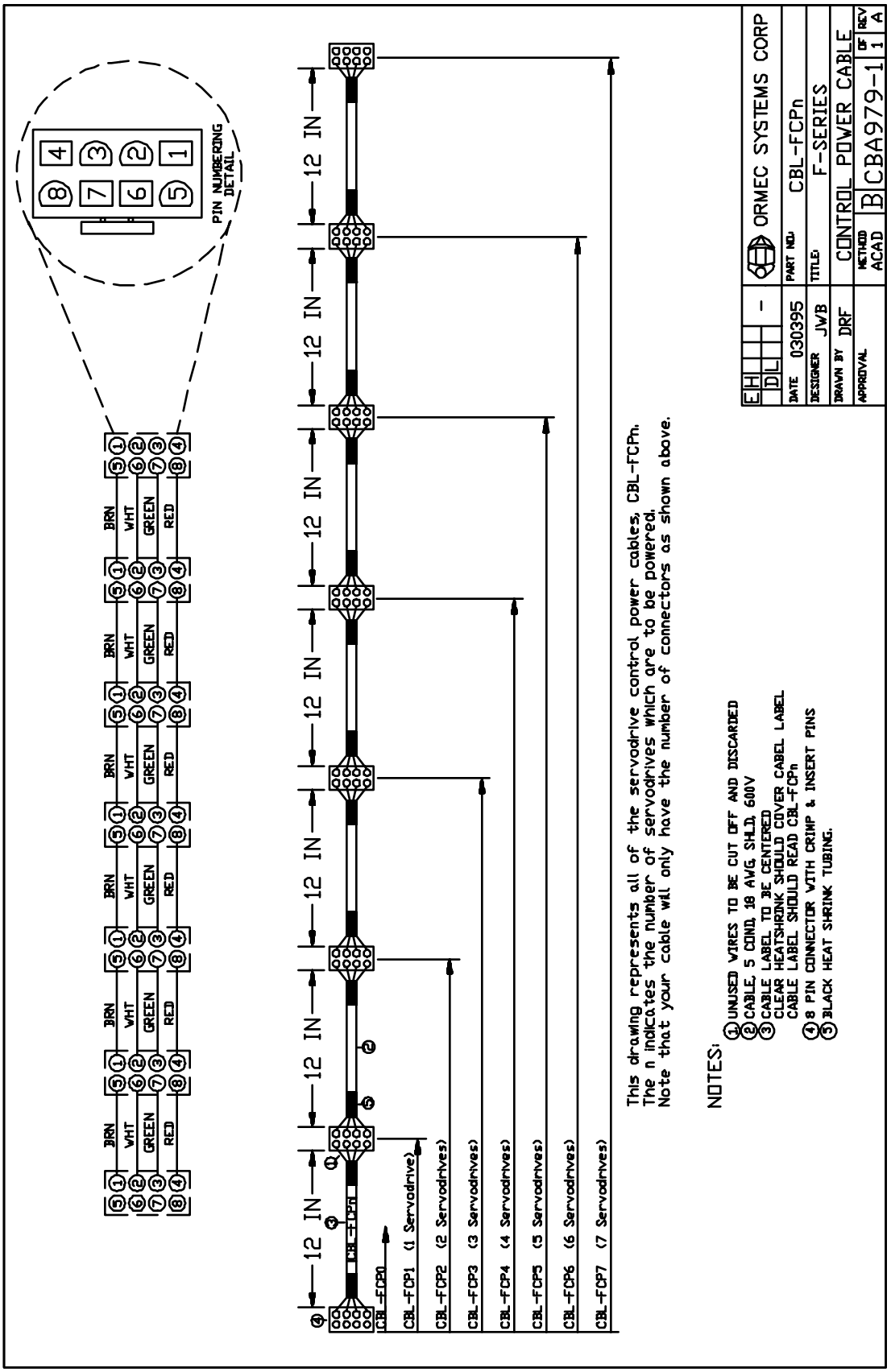
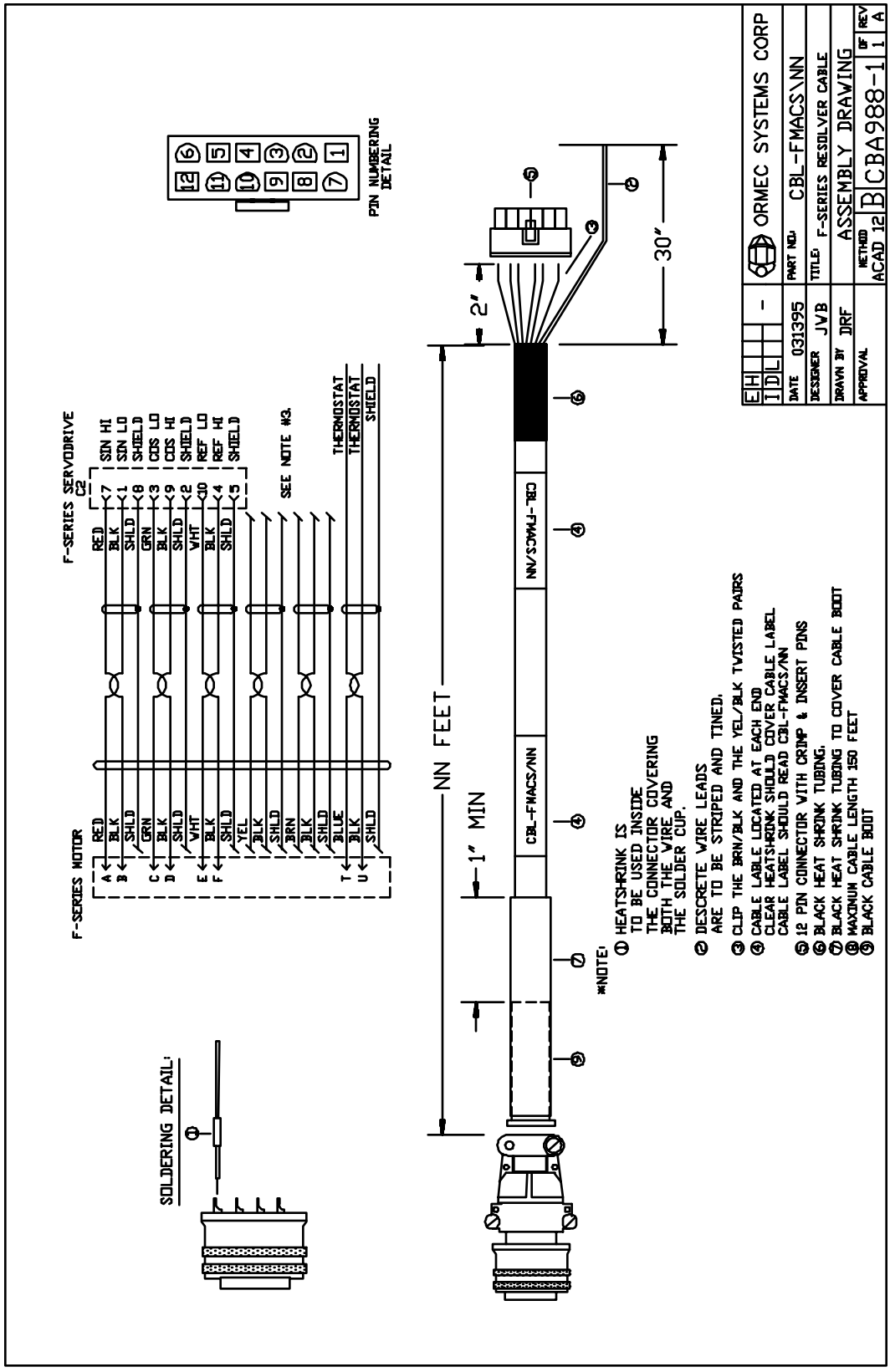
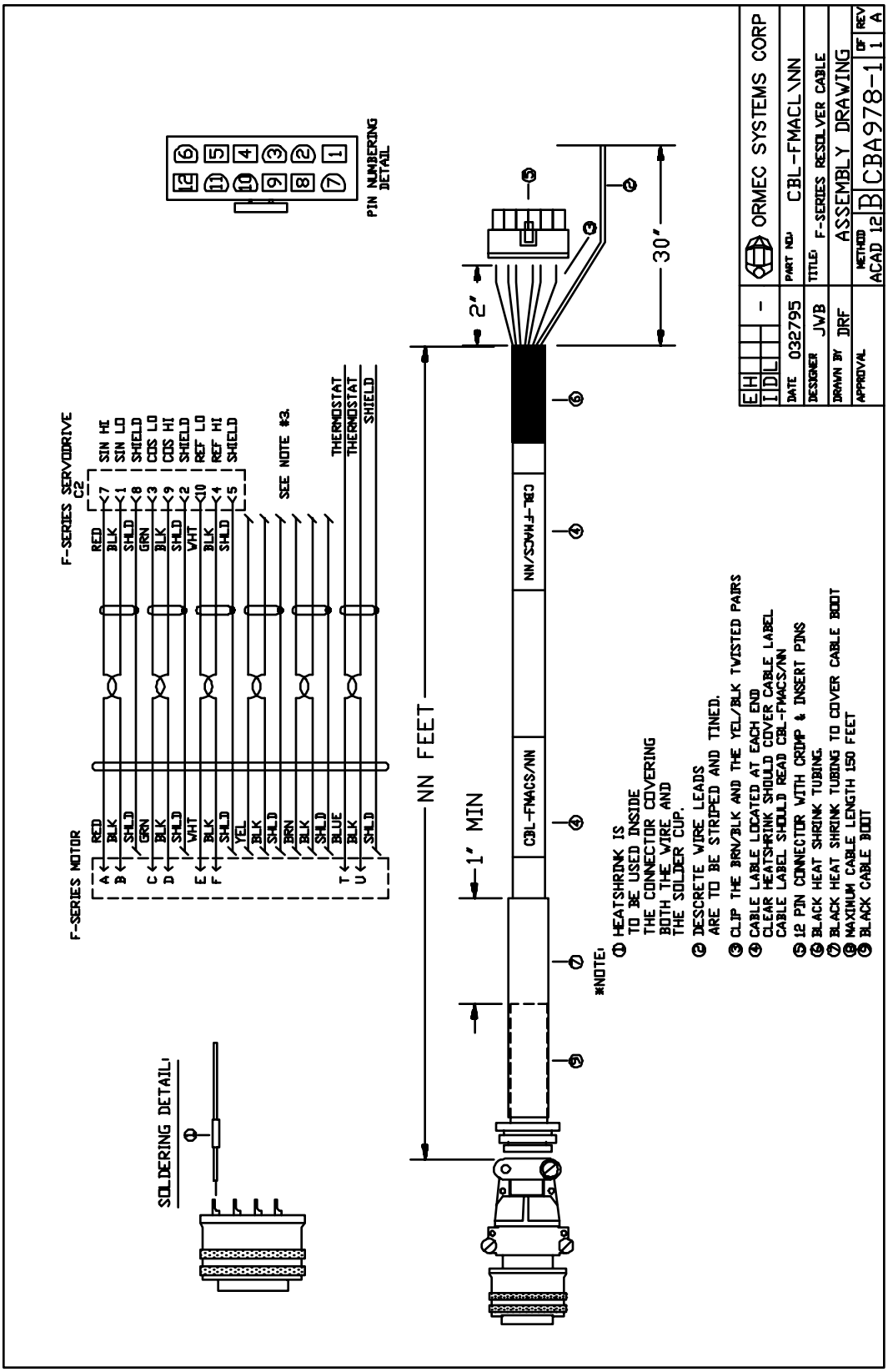
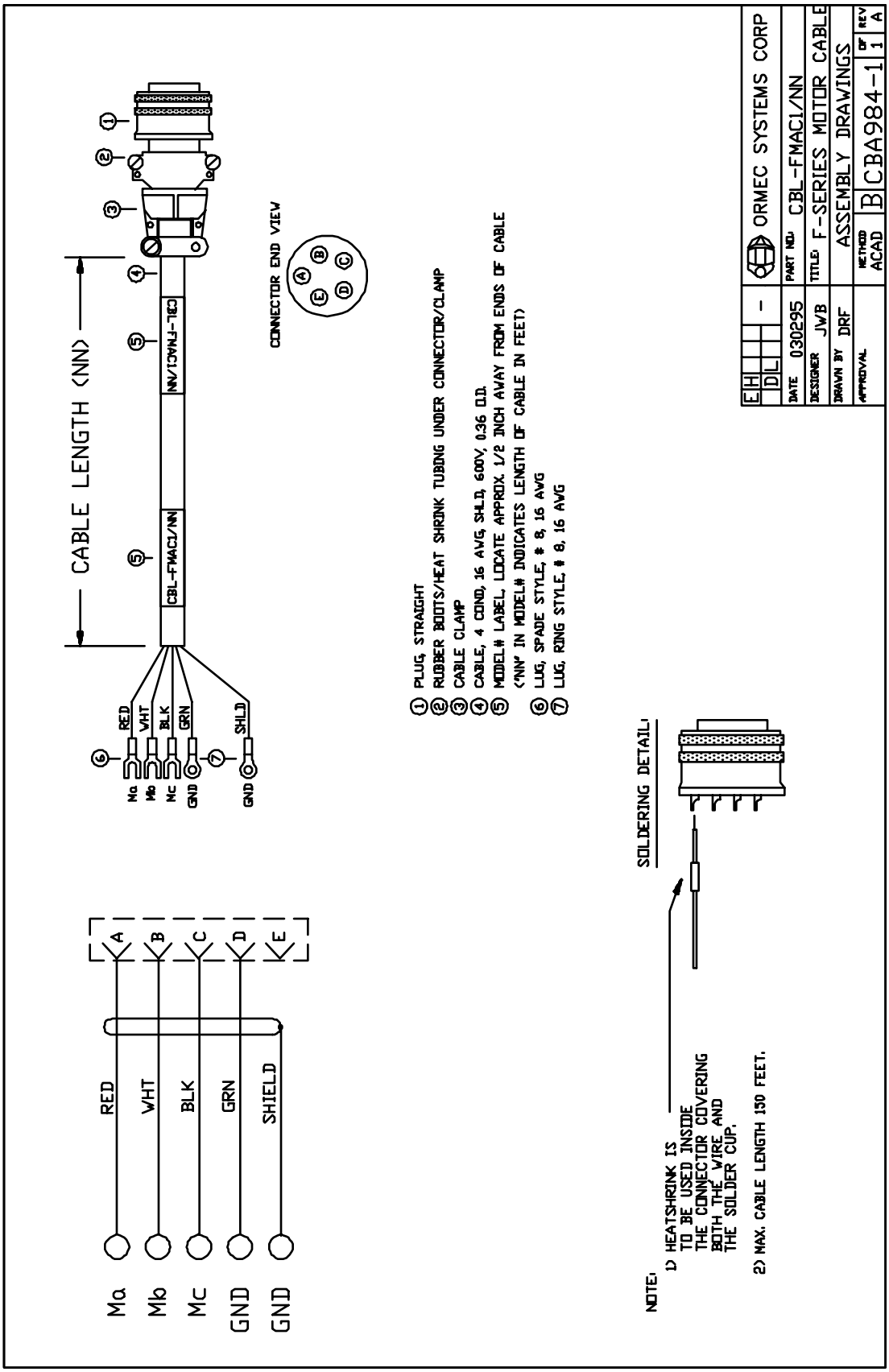
PART NO: TBC-D25
TITLE: TERMINAL BLOCK, 25 POSITION
ASSEMBLY DRAWING
CBA998-1
REV A
DF 1
METHOD ACAD
B
DATE 020792
DESIGNER DVH
DRAWN BY EJB
APPROVAL
EH
DL
1 SNAP-TRACK TERMINAL BLOCK
2 4.5" DF TERMINAL BLOCK MOUNTING RAIL
3.55"
2.76"
25 PIN
MALE D-SUB
1 2 3 4 5 6 7 8 9 10 11 12 13
14 15 16 17 18 19 20 21 22 23 24 25

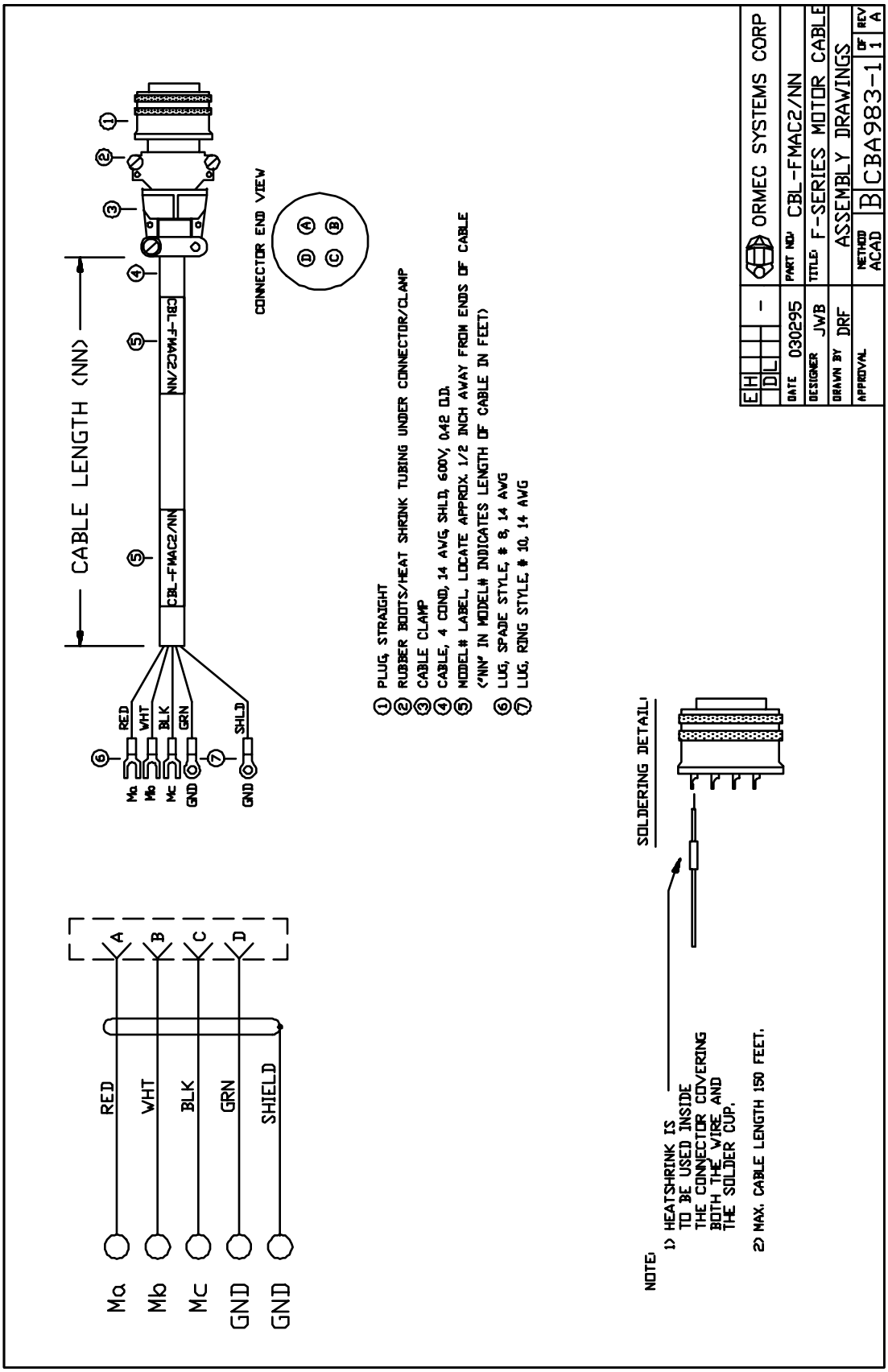

50 FOOT MAXIMUM LENGTH
CBL-AT/NN
CBL-AT/NN
PIN NUMBERING DETAIL
FEMALE CONNECTOR
PIN NUMBERING DETAIL
1 MALE, 26 PIN HI DENSITY CONNECTOR
2 CONNECTOR SHELL W/ THUMB SCREWS
3 TIE WRAP
4 15 TWISTED PAIR, SHIELDED, .42 O.D.
5 CABLE LABEL LOCATED AT EACH END
CLEAR HEATSHRINK SHOULD COVER CABLE LABEL
6 25 PIN FEMALE INSULATION DISPLACEMENT CONNECTOR
TERMINAL BLOCK D-SUB
DSP AXIS MODULE
DRV-CMD
AGND
+5VDC
DGND
ENCA
ENCA
ENCB
ENCB
ENCZ
ENCZ
T-ENABLE
V-
V-
ALM-RESET
ALO1
ALO2
ALO3
NO-ALARM
V-
V+
AIN2
ABS
BAT+
BAT-
SHIELD
N/C
NOTE: ALL UNUSED WIRES TO BE CUT OFF AND DISCARDED
DSP AXIS INTERFACE TO D-SUB CABLE
ORMEC SYSTEMS CORP
PART NO. CBL-AT/NN
TITLE DSP TO TERMINAL BLOCK
ASSEMBLY DRAWING
DATE 10.12.92
DESIGNER RJM
DRAWN BY EJB
APPROVAL
METHOD ACAD 10
B CBA192-1
DF 1
REV B

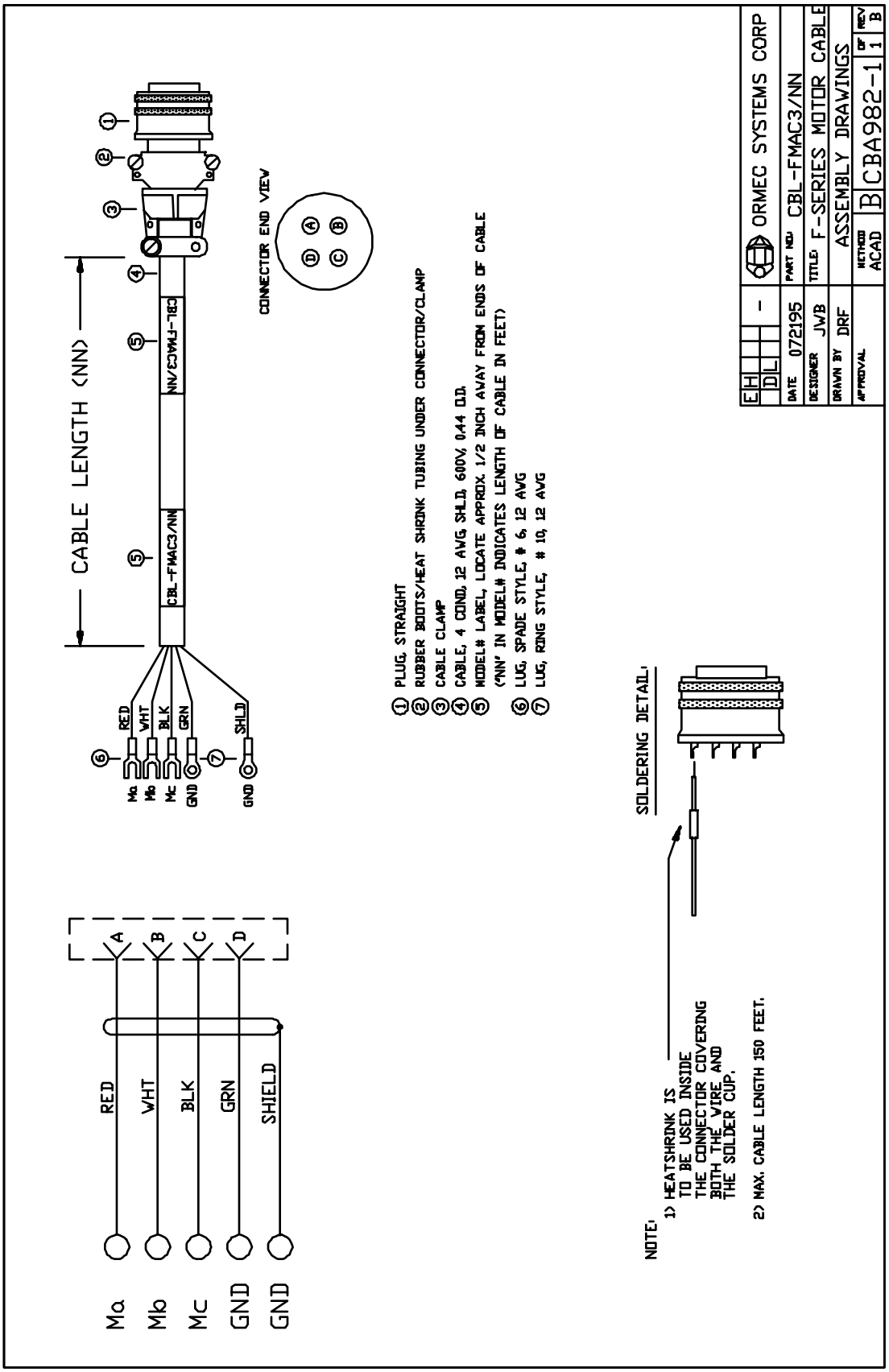

PIN NUMBERING DETAIL
12 IN
CBL-FCPn
CBL-FCP0
CBL-FCP1 (1 Servodrive)
CBL-FCP2 (2 Servodrives)
CBL-FCP3 (3 Servodrives)
CBL-FCP4 (4 Servodrives)
CBL-FCP5 (5 Servodrives)
CBL-FCP6 (6 Servodrives)
CBL-FCP7 (7 Servodrives)
BRN
WHT
GREEN
RED
This drawing represents all of the servodrive control power cables, CBL-FCPn.
The n indicates the number of servodrives which are to be powered.
Note that your cable will only have the number of connectors as shown above.
NOTES:
1 UNUSED WIRES TO BE CUT OFF AND DISCARDED
2 CABLE, 5 COND, 18 AWG, SHLD, 600V
3 CABLE LABEL TO BE CENTERED
CLEAR HEATSHRINK SHOULD COVER CABEL LABEL
CABLE LABEL SHOULD READ CBL-FCPn
4 8 PIN CONNECTOR WITH CRIMP & INSERT PINS
5 BLACK HEAT SHRINK TUBING.
ORMEC SYSTEMS CORP
PART NO: CBL-FCPn
TITLE: F-SERIES
CONTROL POWER CABLE
METHOD ACAD
B CBA979-1
SIZE B
REV A
SHT 1 OF 1
DATE 030395
DESIGNER JWB
DRAWN BY DRF
APPROVAL

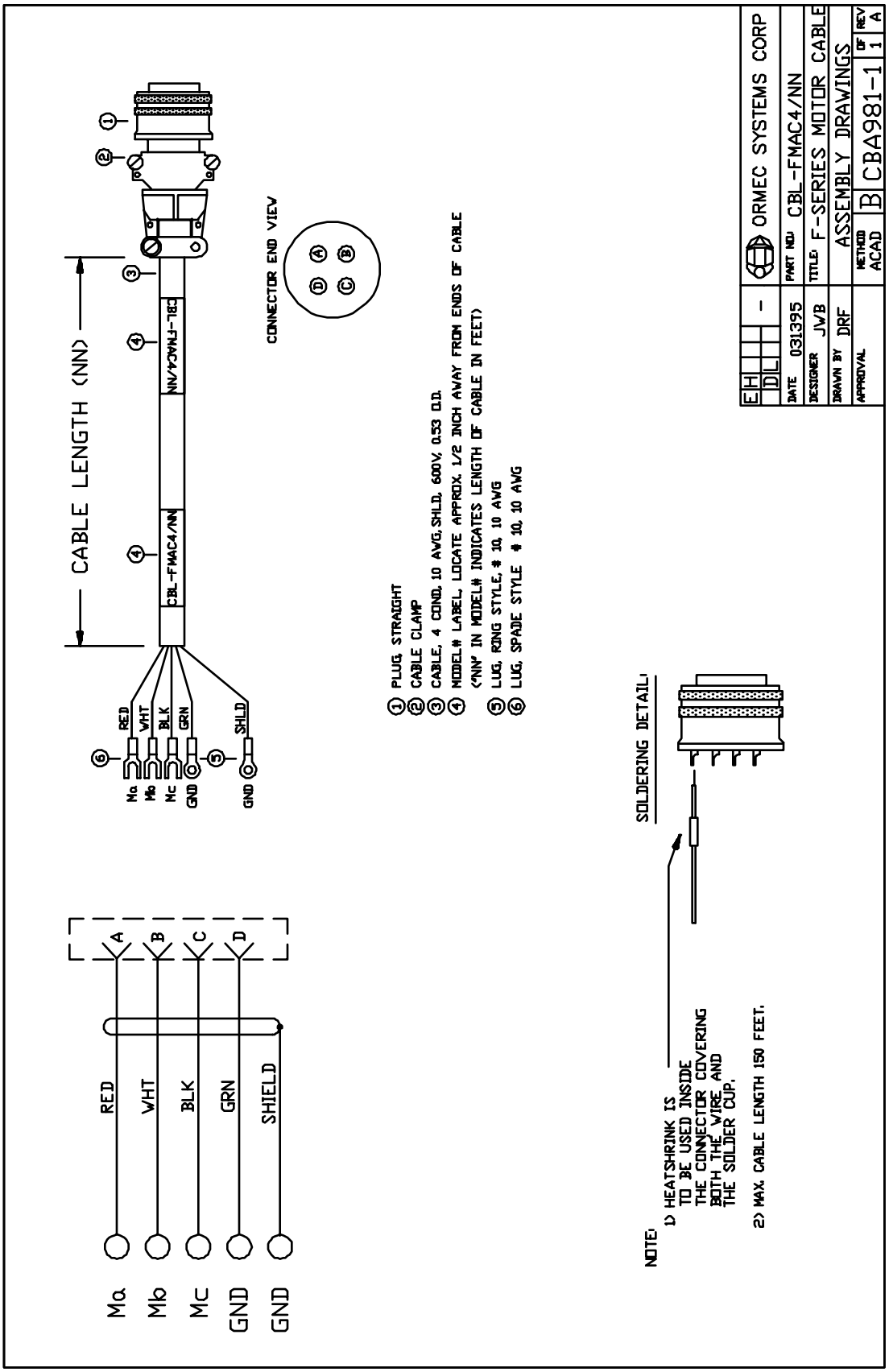

F-SERIES SERVODRIVE
C2
SIN HI
SIN LO
SHIELD
COS LO
COS HI
SHIELD
REF LO
REF HI
SHIELD
THERMOSTAT
THERMOSTAT
SHIELD
SEE NOTE #3.
F-SERIES MOTOR
RED
BLK
SHLD
GRN
BLK
SHLD
WHT
BLK
SHLD
YEL
BLK
SHLD
BRN
BLK
SHLD
BLUE
BLK
SHLD
PIN NUMBERING DETAIL
SOLDERING DETAIL:
NN FEET
1" MIN
2"
30"
CBL-FMACS/NN
CBL-FMACS\NN
*NOTE:
1 HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
2 DESCRETE WIRE LEADS ARE TO BE STRIPED AND TINED.
3 CLIP THE BRN/BLK AND THE YEL/BLK TWISTED PAIRS
4 CABLE LABLE LOCATED AT EACH END CLEAR HEATSHRINK SHOULD COVER CABLE LABEL CABLE LABEL SHOULD READ CBL-FMACS/NN
5 12 PIN CONNECTOR WITH CRIMP & INSERT PINS
6 BLACK HEAT SHRINK TUBING.
7 BLACK HEAT SHRINK TUBING TO COVER CABLE BOOT
8 MAXIMUM CABLE LENGTH 150 FEET
9 BLACK CABLE BOOT
ORMEC SYSTEMS CORP
PART NO: CBL-FMACS\NN
TITLE: F-SERIES RESOLVER CABLE
ASSEMBLY DRAWING
METHOD ACAD 12
BCBA988-1
DF 1 1
REV A
DATE 031395
DESIGNER JVB
DRAWN BY JRF
APPROVAL

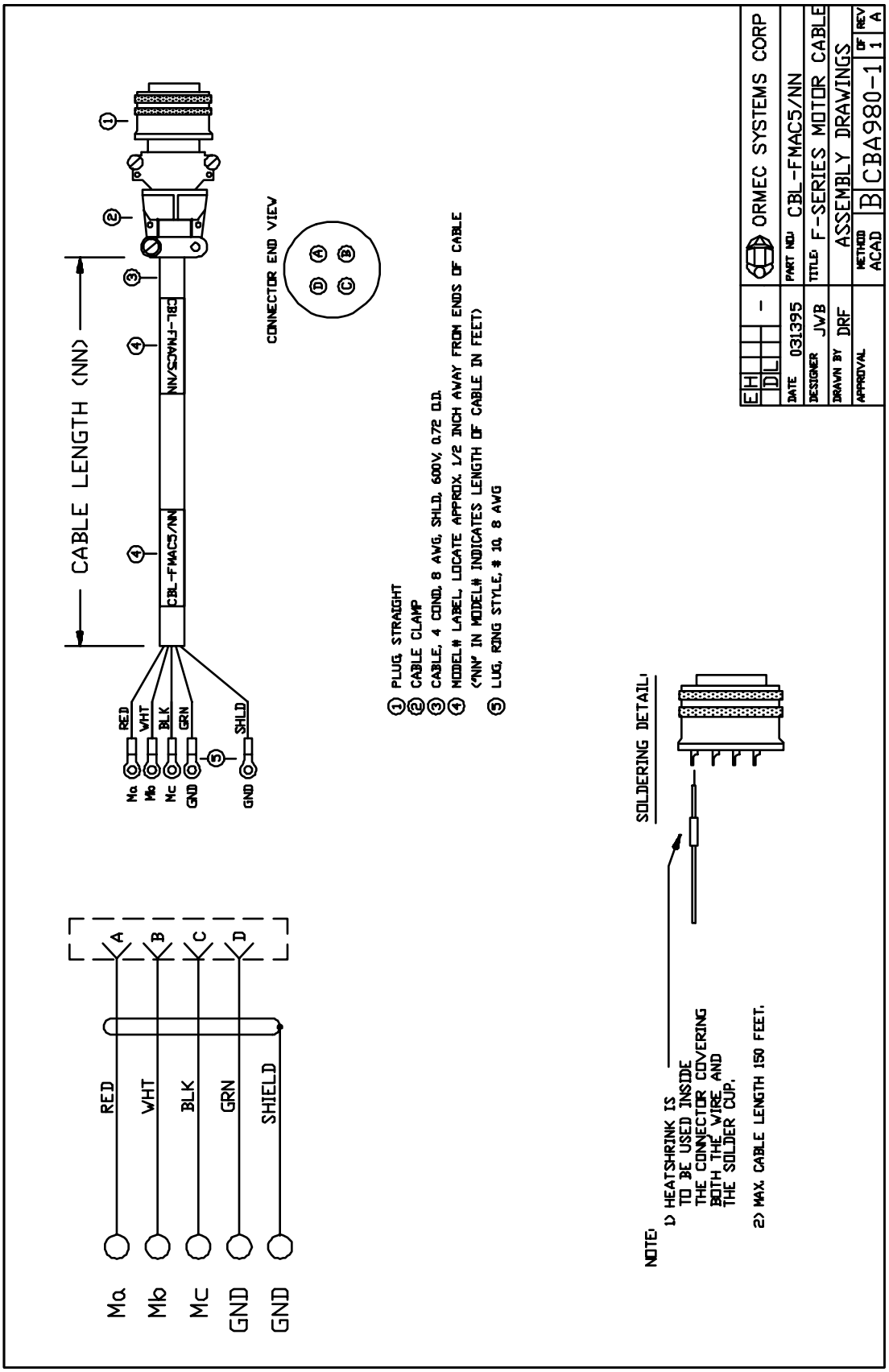

ORMEC SYSTEMS CORP
PART NO. CBL-FMACL\NN
TITLE F-SERIES RESOLVER CABLE
ASSEMBLY DRAWING
METHOD ACAD 12 B CBA978-1 SHT 1 REV A
DATE 032795
DESIGNER JWB
DRAWN BY DRF
APPROVAL
F-SERIES SERVODRIVE C2
F-SERIES MOTOR
SIN HI
SIN LO
SHIELD
COS LO
COS HI
SHIELD
REF LO
REF HI
SHIELD
THERMOSTAT
THERMOSTAT
SHIELD
SEE NOTE #3.
PIN NUMBERING DETAIL
SOLDERING DETAIL
NN FEET
1' MIN
2'
30'
CBL-FMACS/NN
CBL-FMACSJ-NN
*NOTE:
1 HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
2 DESCRETE WIRE LEADS ARE TO BE STRIPED AND TINED.
3 CLIP THE BRN/BLK AND THE YEL/BLK TWISTED PAIRS
4 CABLE LABLE LOCATED AT EACH END CLEAR HEATSHRINK SHOULD COVER CABLE LABEL CABLE LABEL SHOULD READ CBL-FMACS/NN
5 12 PIN CONNECTOR WITH CRIMP & INSERT PINS
6 BLACK HEAT SHRINK TUBING.
7 BLACK HEAT SHRINK TUBING TO COVER CABLE BOOT
8 MAXIMUM CABLE LENGTH 150 FEET
9 BLACK CABLE BOOT

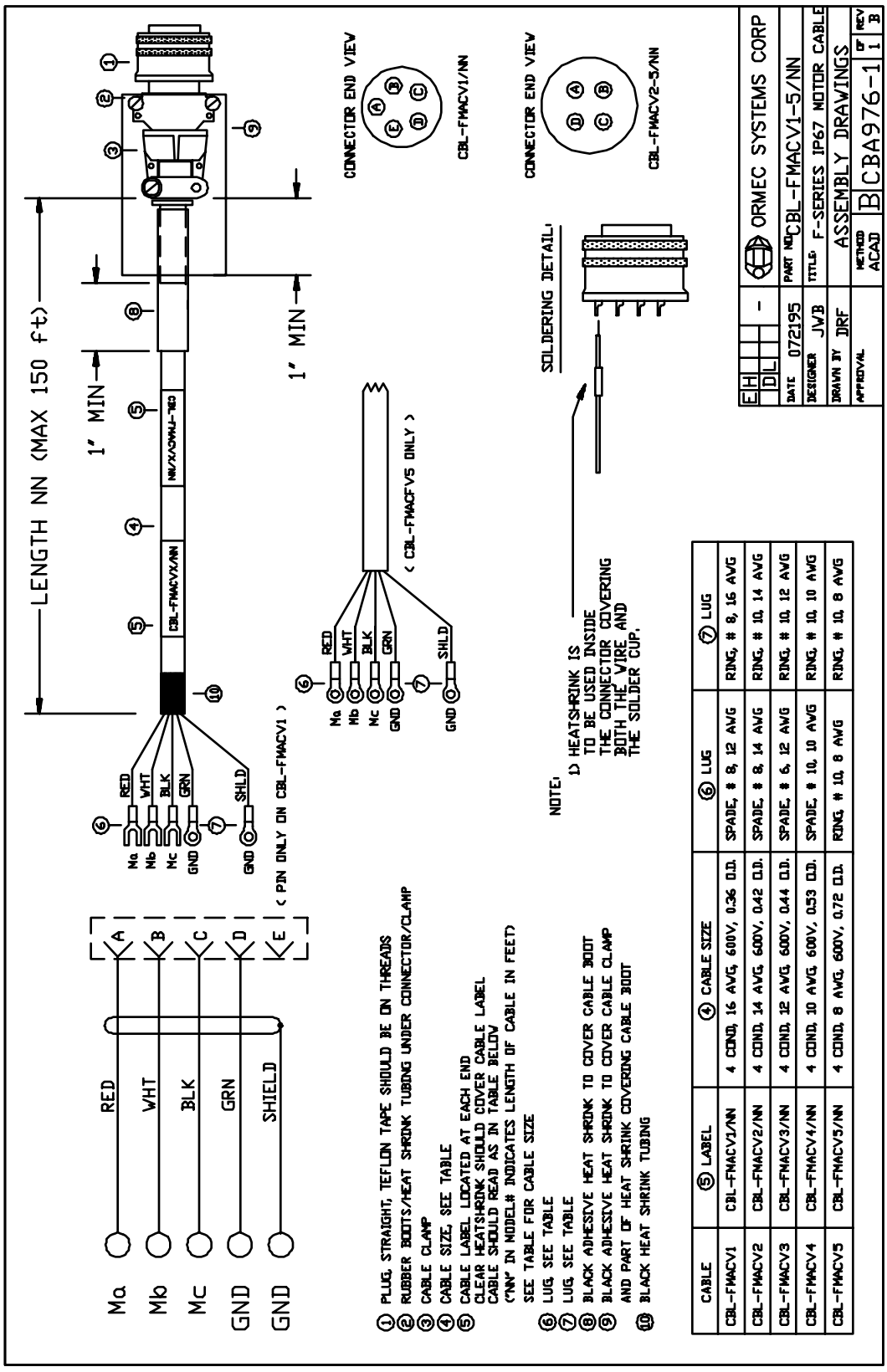

CABLE LENGTH <NN>
CBL-FMAC1/NN
CBL-FMAC1/NN
RED
WHT
BLK
GRN
SHLD
Ma
Mb
Mc
GND
GND
CONNECTOR END VIEW
A
B
C
D
E
RED
WHT
BLK
GRN
SHIELD
Ma
Mb
Mc
GND
GND
1) PLUG, STRAIGHT
2) RUBBER BOOTS/HEAT SHRINK TUBING UNDER CONNECTOR/CLAMP
3) CABLE CLAMP
4) CABLE, 4 COND, 16 AWG, SHLD, 600V, 0.36 O.D.
5) MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE
('NN' IN MODEL# INDICATES LENGTH OF CABLE IN FEET)
6) LUG, SPADE STYLE, # 8, 16 AWG
7) LUG, RING STYLE, # 8, 16 AWG
SOLDERING DETAIL:
NOTE:
1) HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
2) MAX. CABLE LENGTH 150 FEET.
E
H
D
L
-
ORMEC SYSTEMS CORP
DATE 030295
PART NO. CBL-FMAC1/NN
DESIGNER JWB
TITLE F-SERIES MOTOR CABLE
DRAWN BY DRF
ASSEMBLY DRAWINGS
APPROVAL
METHOD ACAD
B CBA984-1
SHT 1
REV A


CABLE LENGTH (NN)
CBL-FMAC2/NN
NN/23WHJ-7B3
RED
WHT
BLK
GRN
SHLD
Ma
Mb
Mc
GND
GND
CONNECTOR END VIEW
① PLUG, STRAIGHT
② RUBBER BOOTS/HEAT SHRINK TUBING UNDER CONNECTOR/CLAMP
③ CABLE CLAMP
④ CABLE, 4 COND, 14 AWG, SHLD, 600V, 0.42 O.D.
⑤ MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE ('NN' IN MODEL# INDICATES LENGTH OF CABLE IN FEET)
⑥ LUG, SPADE STYLE, # 8, 14 AWG
⑦ LUG, RING STYLE, # 10, 14 AWG
SOLDERING DETAIL
NOTE:
1) HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
2) MAX. CABLE LENGTH 150 FEET.
A
B
C
D
RED
WHT
BLK
GRN
SHIELD
Ma
Mb
Mc
GND
GND
E
H
D
L
-
ORMEC SYSTEMS CORP
DATE 030295
PART NO: CBL-FMAC2/NN
DESIGNER JWB
TITLE: F-SERIES MOTOR CABLE
DRAWN BY DRF
ASSEMBLY DRAWINGS
APPROVAL
METHOD ACAD
BCBA983-1
OF 1
REV A


CABLE LENGTH <NN>
CBL-FMAC3/NN
CBL-FMAC3/NN
RED
WHT
BLK
GRN
SHLD
Ma
Mb
Mc
GND
GND
CONNECTOR END VIEW
A
B
C
D
1) PLUG, STRAIGHT
2) RUBBER BOOTS/HEAT SHRINK TUBING UNDER CONNECTOR/CLAMP
3) CABLE CLAMP
4) CABLE, 4 COND, 12 AWG SHLD, 600V, 0.44 O.D.
5) MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE ('NN' IN MODEL# INDICATES LENGTH OF CABLE IN FEET)
6) LUG, SPADE STYLE, # 6, 12 AVG
7) LUG, RING STYLE, # 10, 12 AVG
SOLDERING DETAIL:
NOTE:
1) HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
2) MAX. CABLE LENGTH 150 FEET.
ORMEC SYSTEMS CORP
PART NO: CBL-FMAC3/NN
TITLE: F-SERIES MOTOR CABLE
ASSEMBLY DRAWINGS
METHOD ACAD
BCBA982-1
DF 1 1
REV B
DATE 072195
DESIGNER JWB
DRAWN BY DRF
APPROVAL


CABLE LENGTH (NN)
CBL-FMAC4/NN
CBL-FMAC4/NN
RED
WHT
BLK
GRN
SHLD
Ma
Mb
Mc
GND
GND
CONNECTOR END VIEW
A
B
C
D
RED
WHT
BLK
GRN
SHIELD
Ma
Mb
Mc
GND
GND
1) PLUG, STRAIGHT
2) CABLE CLAMP
3) CABLE, 4 COND, 10 AWG, SHLD, 600V, 0.53 O.D.
4) MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE ('NN' IN MODEL# INDICATES LENGTH OF CABLE IN FEET)
5) LUG, RING STYLE, # 10, 10 AWG
6) LUG, SPADE STYLE # 10, 10 AWG
SOLDERING DETAIL
NOTE:
1) HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
2) MAX. CABLE LENGTH 150 FEET.
ORMEC SYSTEMS CORP
PART NO: CBL-FMAC4/NN
TITLE: F-SERIES MOTOR CABLE
ASSEMBLY DRAWINGS
METHOD ACAD
B CBA981-1
SIZE B
REV A
SHT 1
DATE 031395
DESIGNER JWB
DRAWN BY DRF
APPROVAL


CABLE LENGTH (NN)
CBL-FMAC5/NN
RED
WHT
BLK
GRN
SHLD
Ma
Mb
Mc
GND
GND
CONNECTOR END VIEW
① PLUG, STRAIGHT
② CABLE CLAMP
③ CABLE, 4 COND, 8 AWG, SHLD, 600V, 0.72 O.D.
④ MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE ('NN' IN MODEL# INDICATES LENGTH OF CABLE IN FEET)
⑤ LUG, RING STYLE, # 10, 8 AWG
SOLDERING DETAIL
NOTE:
1) HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
2) MAX. CABLE LENGTH 150 FEET.
A
B
C
D
RED
WHT
BLK
GRN
SHIELD
Ma
Mb
Mc
GND
GND
ORMEC SYSTEMS CORP
PART NO: CBL-FMAC5/NN
TITLE: F-SERIES MOTOR CABLE
ASSEMBLY DRAWINGS
METHOD ACAD
BCBA980-1
DF 1 1
REV A
DATE 031395
DESIGNER JWB
DRAWN BY DRF
APPROVAL



CABLE	⑤ LABEL	④ CABLE SIZE	⑥ LUG	⑦ LUG
CBL-FMACV1	CBL-FMACV1/NN	4 COND, 16 AWG, 600V, 0.36 O.D.	SPADE, # 8, 12 AWG	RING, # 8, 16 AWG
CBL-FMACV2	CBL-FMACV2/NN	4 COND, 14 AWG, 600V, 0.42 O.D.	SPADE, # 8, 14 AWG	RING, # 10, 14 AWG
CBL-FMACV3	CBL-FMACV3/NN	4 COND, 12 AWG, 600V, 0.44 O.D.	SPADE, # 6, 12 AWG	RING, # 10, 12 AWG
CBL-FMACV4	CBL-FMACV4/NN	4 COND, 10 AWG, 600V, 0.53 O.D.	SPADE, # 10, 10 AWG	RING, # 10, 10 AWG
CBL-FMACV5	CBL-FMACV5/NN	4 COND, 8 AWG, 600V, 0.72 O.D.	RING, # 10, 8 AWG	RING, # 10, 8 AWG

Appendix E
Washdown Motors

Washdown Motors

F-Series servomotors are available in an optional Washdown housing version. An "F" in the motor options field indicates that the motor is a Washdown version. Refer to the part numbers below as examples.

MAC-F060A/S**F**

MAC-F155A/S**F**

F-Series Washdown motors are designed to meet FDA quidelines[5], however, these motors are not UL recognized (standard F-Series motors are UL recognized). All F-Series Washdown motors are supplied with smooth motor housings, stainless steel shafts, IP-67 sealing, 1/4" NPT fittings for ventilation, and painted with FDA approved food edible epoxy paint. F-Series Washdown motors are not supplied with MS series connectors, refer to the Installation section of this Appendix for further information regarding the motor and resolver cable connections.

Specifications

All the standard F-Series motor specifications apply to F-Series Washdown motors, except as noted in this section. Refer to MAC-F Series Servomotors Specifications section of the Specifications chapter for further information.

Torque and Current

The continuous torque and current capability of a F-Series Washdown motor is 10% less than it's standard F-Series equivalent. This is because Washdown motor housings are smooth to prevent collection of liquids on the motor, therefore there is no fin radiation on the motor to promote cooling, resulting in less efficient heat dissipation.

[5] The liquid tight seals supplied with Washdown motor cables might not comply to FDA guidelines. Refer to the Installation section of this appendix for further information.

Mechanical Dimensions

The weight, mounting bolt diameter, length (mounting face to rear) and Maximum shaft load are different for F-Series Washdown motors than for the standard F-Series motors. Refer to the Motor Outline drawings included in this Appendix for further information.

Thermal Time Constant

The thermal time constant for a F-Series Washdown motor is less than it's explosion proof F-Series equivalent.

Installation

All the installation instructions for F-Series Washdown motors are the same as those for standard F-Series motors, except as noted in this section. Refer to the Servomotor Installation section of the Installation chapter for further information.

NOTE: Liquid tight seals provided with Washdown motor cables may not meet FDA requirements. The seals supplied with the Washdown motor cables can be installed to provide a water tight seal, however, they are made of mallable aluminum, which may not meet FDA guidelines for certain installations. Stainless steel versions of these seals are available from Hubbell, refer to the following table.

ORMEC Cable	**Hubbell Part Number**
CBL-FMACFL	SHC-1022-SS
CBL-FMACF2	SHC-1023-SS
CBL-FMACF3	SHC-1023-SS
CBL-FMACF4	SHC-1036-SS
CBL-FMACF5	SHC-1041-SS

MAC-F007A/SF - MAC-F040A/SF Cable Connections

The MAC-F007A/SF through MAC-F040A/SF motors are supplied with 2 foot motor and resolver leads exiting the motor through a single NPT fitting provided in the housing. The NPT fitting is intended for attaching liquid tight cable conduit, or liquid tight junction box, directly to the motor. Be sure to wrap the cable conduit threads with teflon tape (or equivalent) to insure a liquid tight seal with the motor housing.

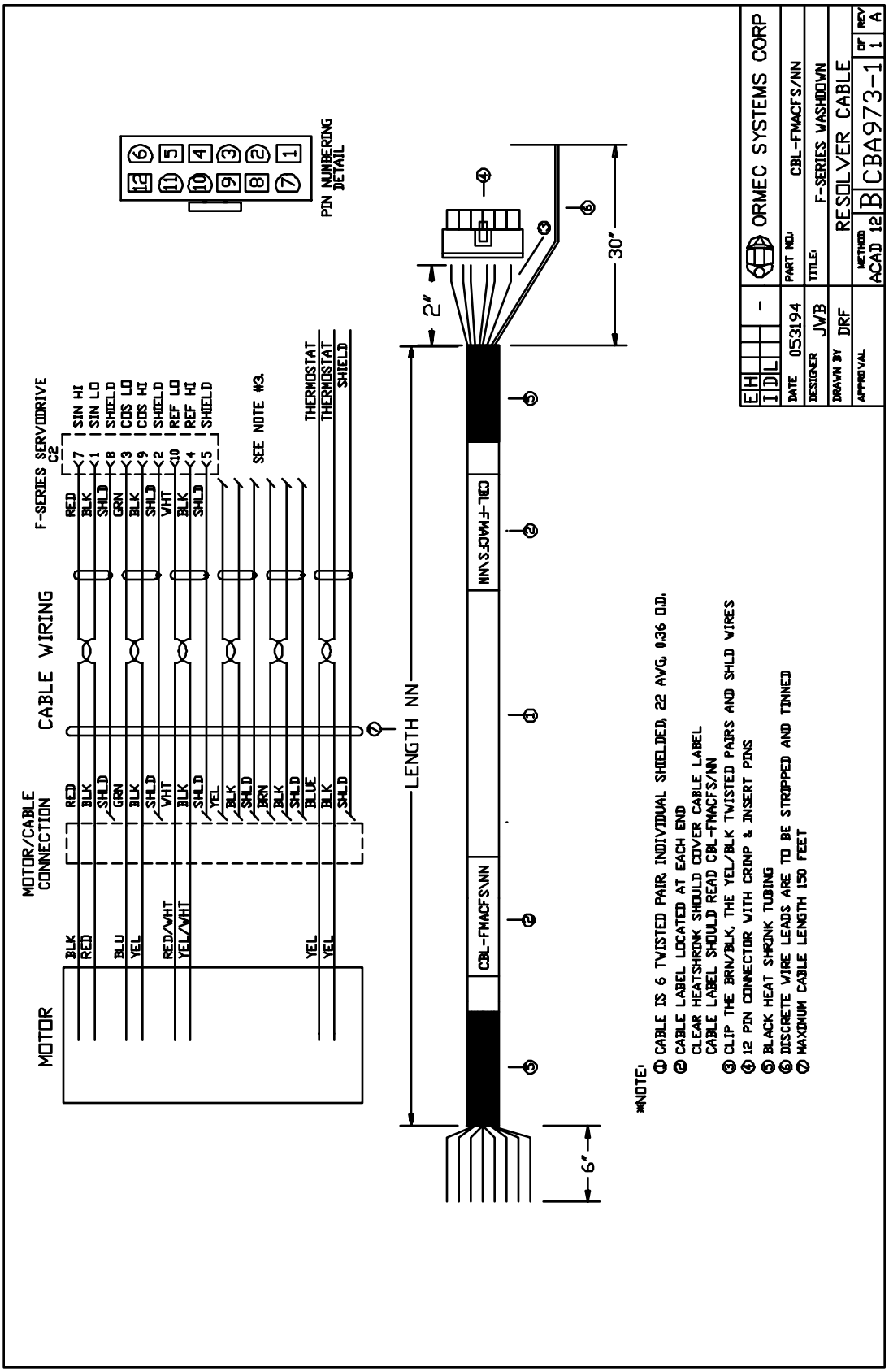
For MAC-F007A/SF through MAC-F040A/SF motors a CBL-FMACFS/NN is used for the resolver connections, and a CBL-FMACF1/NN is used for the motor connections. Refer to the CBL-FMACFS/NN and CBL-FMACF1/NN drawings included in this Appendix for further cable and installation information.

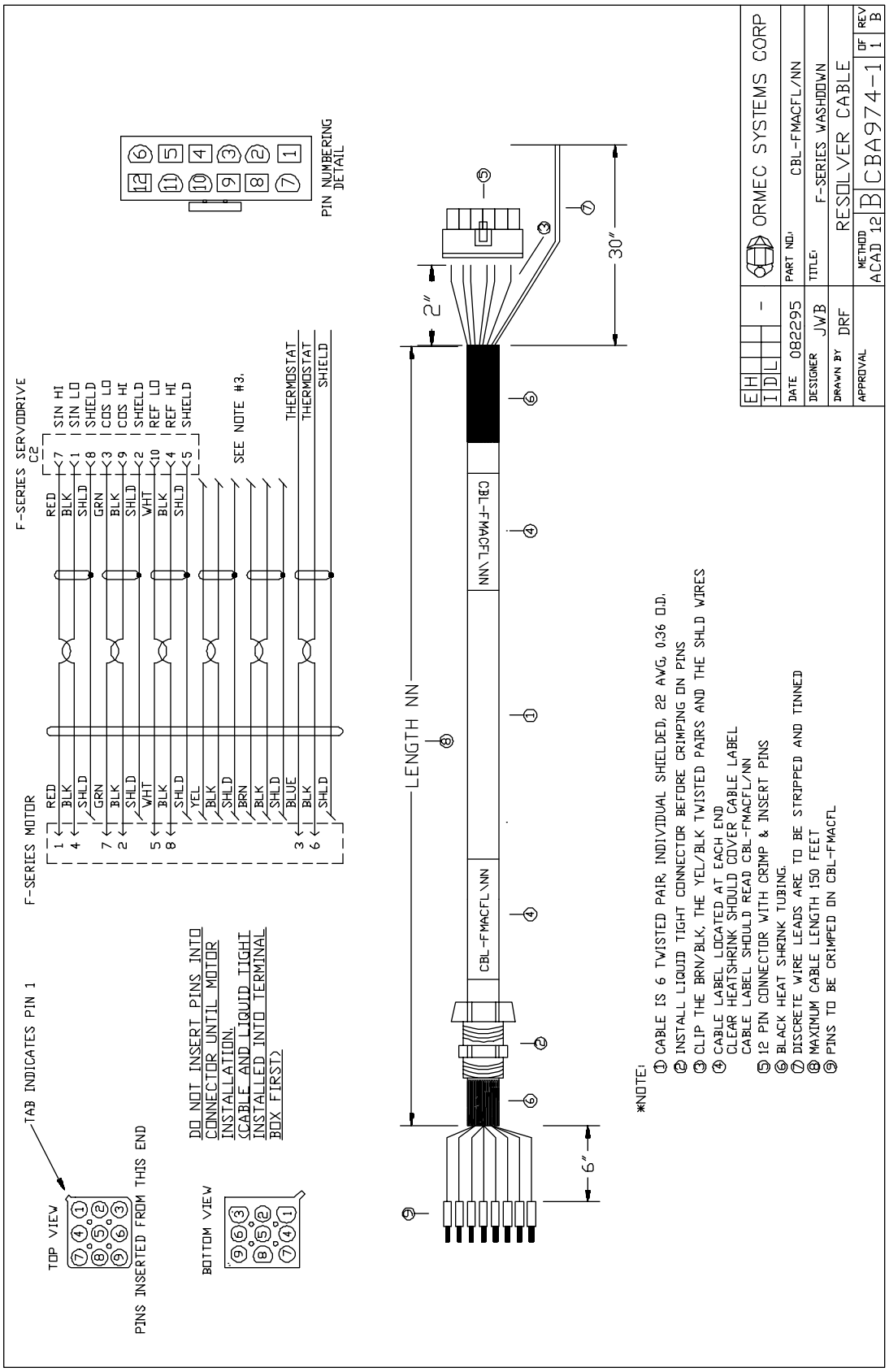
MAC-F060A/SF - MAC-F960A/SF Cable Connections

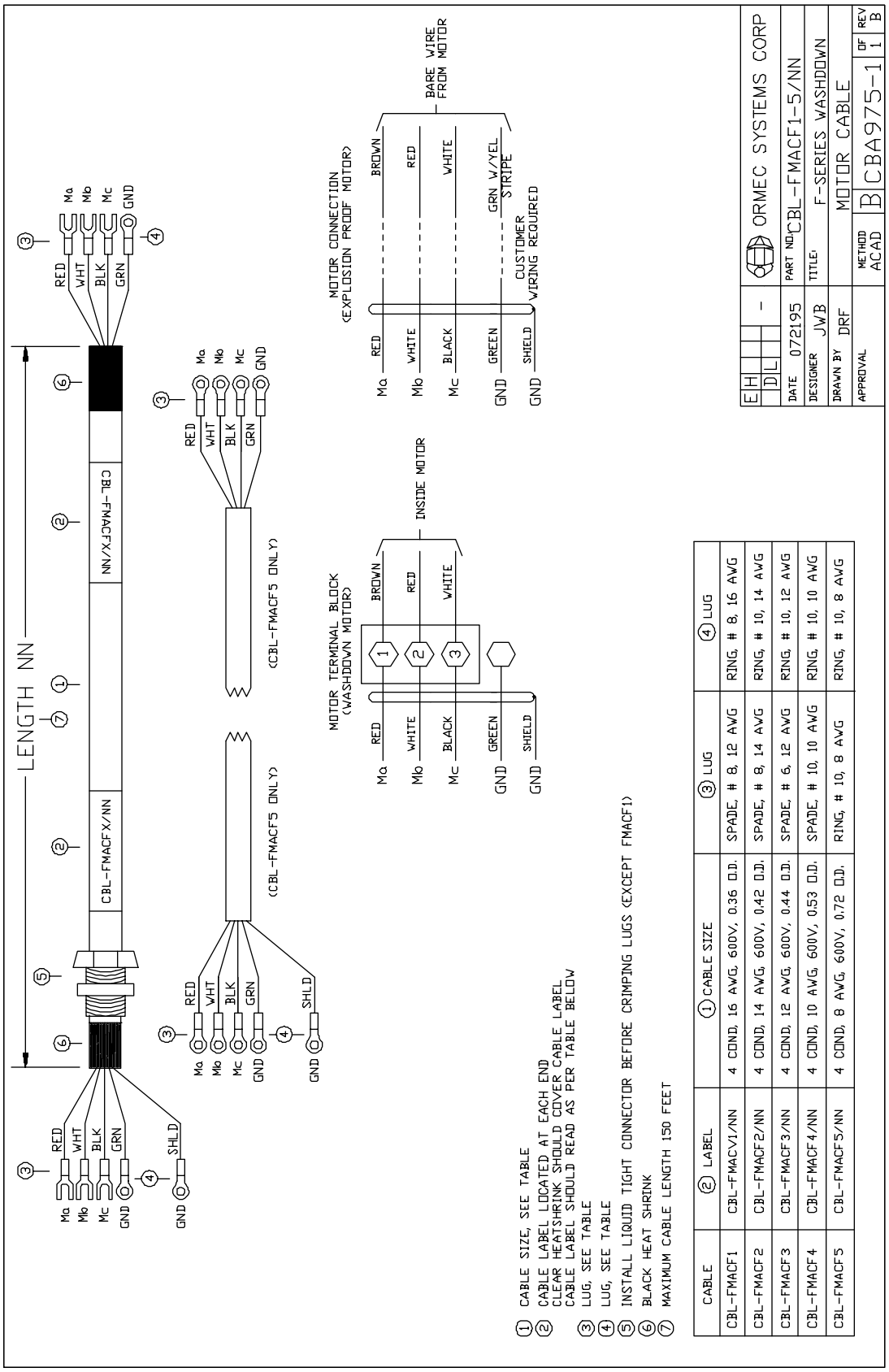
The MAC-F060A/SF through MAC-F960A/SF motors are supplied with a terminal box for the motor and resolver cable connections. This terminal box contains a terminal strip for the motor connections and a connector for the resolver connections.

For MAC-F060A/SF through MAC-F960A/SF motors a CBL-FMACFL is used for the resolver connections. Refer to the CBL-FMACFL/NN drawing included in this Appendix for further information. This cable is supplied with a liquid tight seal, pins (Amp p/n 350690-1) crimped on the motor end of the cable, and a separate connector housing(Amp p/n 1-641769-0). During installation the motor end of the cable is inserted into the motor's terminal box, and the liguid tight seal is screwed into the threaded hole provided. Be sure to wrap the liquid tight seal threads with teflon tape (or equivalent) to insure a liquid tight seal with the terminal box. After the cable has been inserted into the terminal box, and the liquid tight seal has been screwed into place, the pins can be inserted into the resolver connector. Once inserted the connector pins cannot be removed without the appropriate extraction tool (Amp p/n 458994-2). A set of pins and a connector housing are included with each F-Series Washdown motor.

For MAC-F060A/SF through MAC-F960A/SF motors a CBL-FMACF1-5 is used for the motor connections. Refer to the CBL-FMACF1-5/NN drawing included in this Appendix for further information. This cable is supplied with a liquid tight seal and lugs crimped on the motor end. During installation the motor end of the cable is inserted into the motor's terminal box, and the liguid tight seal is screwed into the threaded hole provided. Be sure to wrap the liquid tight seal threads with teflon tape (or equivalent) to insure a liquid tight seal with the terminal box. Attach the motor cable to the terminal strip as indicated on the CBL-FMACF1-5/NN drawing. Connect the green GND wire to the ground screw (not on the terminal strip) supplied in the terminal box, as indicated on the CBL-FMACF1-5/NN drawing.

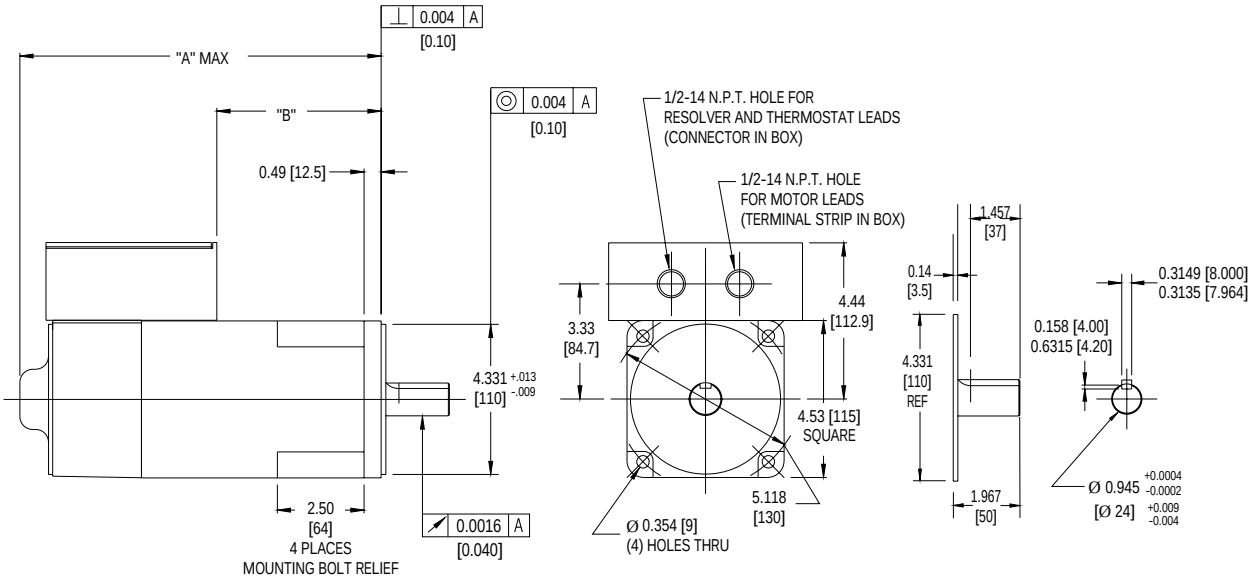

MOTOR
MOTOR/CABLE CONNECTION
CABLE WIRING
F-SERIES SERVODRIVE C2
SIN HI
SIN LO
SHIELD
COS LO
COS HI
SHIELD
REF LO
REF HI
SHIELD
SEE NOTE #3.
THERMOSTAT
THERMOSTAT
SHIELD
PIN NUMBERING DETAIL
LENGTH NN
CBL-FMACFSNN
CBL-FMACFSNN
2"
30"
6"
*NOTE:
1 CABLE IS 6 TWISTED PAIR, INDIVIDUAL SHIELDED, 22 AWG, 0.36 O.D.
2 CABLE LABEL LOCATED AT EACH END
CLEAR HEATSHRINK SHOULD COVER CABLE LABEL
CABLE LABEL SHOULD READ CBL-FMACFS/NN
3 CLIP THE BRN/BLK, THE YEL/BLK TWISTED PAIRS AND SHLD WIRES
4 12 PIN CONNECTOR WITH CRIMP & INSERT PINS
5 BLACK HEAT SHRONK TUBING
6 DISCRETE WIRE LEADS ARE TO BE STRIPPED AND TINNED
7 MAXIMUM CABLE LENGTH 150 FEET
ORMEC SYSTEMS CORP
PART NO: CBL-FMACFS/NN
TITLE: F-SERIES WASHDOWN
RESOLVER CABLE
METRIC ACAD 12
B CBA973-1
REV A
DRAWN BY DRF
DESIGNER JWB
DATE 053194
APPROVAL


F-SERIES SERVODRIVE
C2
F-SERIES MOTOR
RED
BLK
SHLD
GRN
BLK
SHLD
WHT
BLK
SHLD
YEL
BLK
SHLD
BRN
BLK
SHLD
BLUE
BLK
SHLD
SIN HI
SIN LO
SHIELD
COS LO
COS HI
SHIELD
REF LO
REF HI
SHIELD
THERMOSTAT
THERMOSTAT
SHIELD
SEE NOTE #3.
PIN NUMBERING DETAIL
TAB INDICATES PIN 1
TOP VIEW
PINS INSERTED FROM THIS END
BOTTOM VIEW
DO NOT INSERT PINS INTO CONNECTOR UNTIL MOTOR INSTALLATION. (CABLE AND LIQUID TIGHT INSTALLED INTO TERMINAL BOX FIRST)
LENGTH NN
CBL-FMACFL NN
CBL-FMACFL NN
2"
30"
6"
*NOTE:
① CABLE IS 6 TWISTED PAIR, INDIVIDUAL SHIELDED, 22 AWG, 0.36 O.D.
② INSTALL LIQUID TIGHT CONNECTOR BEFORE CRIMPING ON PINS
③ CLIP THE BRN/BLK, THE YEL/BLK TWISTED PAIRS AND THE SHLD WIRES
④ CABLE LABEL LOCATED AT EACH END
CLEAR HEATSHRINK SHOULD COVER CABLE LABEL
CABLE LABEL SHOULD READ CBL-FMACFL/NN
⑤ 12 PIN CONNECTOR WITH CRIMP & INSERT PINS
⑥ BLACK HEAT SHRINK TUBING.
⑦ DISCRETE WIRE LEADS ARE TO BE STRIPPED AND TINNED
⑧ MAXIMUM CABLE LENGTH 150 FEET
⑨ PINS TO BE CRIMPED ON CBL-FMACFL
E/H
T/D/L
-
ORMEC SYSTEMS CORP
DATE 082295
PART NO: CBL-FMACFL/NN
DESIGNER JWB
TITLE: F-SERIES WASHDOWN
DRAWN BY DRF
RESOLVER CABLE
APPROVAL
METHOD ACAD 12
B CBA974-1
SF 1
REV B



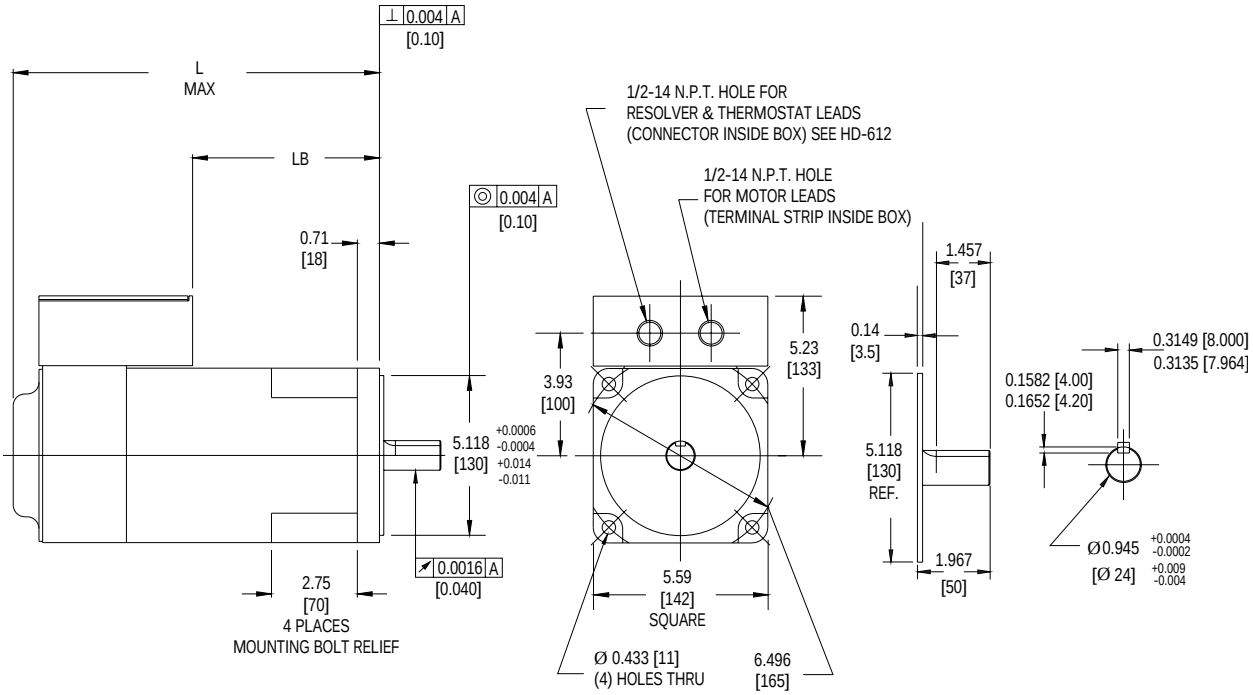
CABLE	② LABEL	① CABLE SIZE	③ LUG	④ LUG
CBL-FMACF1	CBL-FMACV1/NN	4 COND, 16 AWG, 600V, 0.36 O.D.	SPADE, # 8, 12 AWG	RING, # 8, 16 AWG
CBL-FMACF2	CBL-FMACF2/NN	4 COND, 14 AWG, 600V, 0.42 O.D.	SPADE, # 8, 14 AWG	RING, # 10, 14 AWG
CBL-FMACF3	CBL-FMACF3/NN	4 COND, 12 AWG, 600V, 0.44 O.D.	SPADE, # 6, 12 AWG	RING, # 10, 12 AWG
CBL-FMACF4	CBL-FMACF4/NN	4 COND, 10 AWG, 600V, 0.53 O.D.	SPADE, # 10, 10 AWG	RING, # 10, 10 AWG
CBL-FMACF5	CBL-FMACF5/NN	4 COND, 8 AWG, 600V, 0.72 O.D.	RING, # 10, 8 AWG	RING, # 10, 8 AWG

MAC-F060_/SF & F115_/SF Outline Drawing



Motor	L	LB
MAC-F060_/SF	10.5 [266]	4.8 [122]
MAC-F115_/SF	12.6 [319]	6.9 [176]

MAC-F155_/SF & F265_/SF Outline Drawing



Motor	L	LB
MAC-F155_/SF	11.8 [299]	6.0 [152]
MAC-F265_/SF	14.5 [368]	8.7 [221]

Appendix F
Explosion Proof Motors

Explosion Proof Motors

F-Series servomotors are available in an optional Explosion Proof housing version. A "P" in the motor options field indicates that the motor is a Explosion Proof version. Refer to the part numbers below as examples.

MAC-F060A/S**P**

MAC-F155A/S**P**

F-Series Explosion Proof motors are UL Listed as suitable for use in Class 1, Division 1, Groups C and D hazardous locations. This listing includes applications where vapors or gases form flammable or explosive environments. F-Series motors have been tested and proven capable of withstanding internal explosion without bursting or allowing ignition to reach beyond the motor frame.

F-Series Explosion Proof motors feature:

- Cast aluminum housings which promote heat transfer and reduce accidental sparking.
- Motor housings with NPT fittings for connection of explosion proof conduit for resolver and motor conductors.
- Class H winding insulation
- Double sealed ABEC 3 ball bearings

If you have any questions regarding the features of a F-Series Explosion Proof motor, or regarding an application that might require an Explosion Proof motor, contact your ORMEC Sales and Applications Engineer.

Specifications

All the standard F-Series motor specifications apply to F-Series Explosion Proof motors, except as noted in this section. Refer to MAC-F Series

Servomotors Specifications section of the Specifications chapter for further information.

Mechanical Dimensions

The weight, mounting bolt diameter, and length (mounting face to rear) are different for F-Series Explosion Proof motors than for the standard F-Series motors. Refer to the motor Outline drawings included in this Appendix for further information.

Thermal Time Constant

The thermal time constant for an explosion proof motor is different than for the standard F-Series equivalent. Refer to the motor Outline Drawings included in this Appendix for further information.

Installation

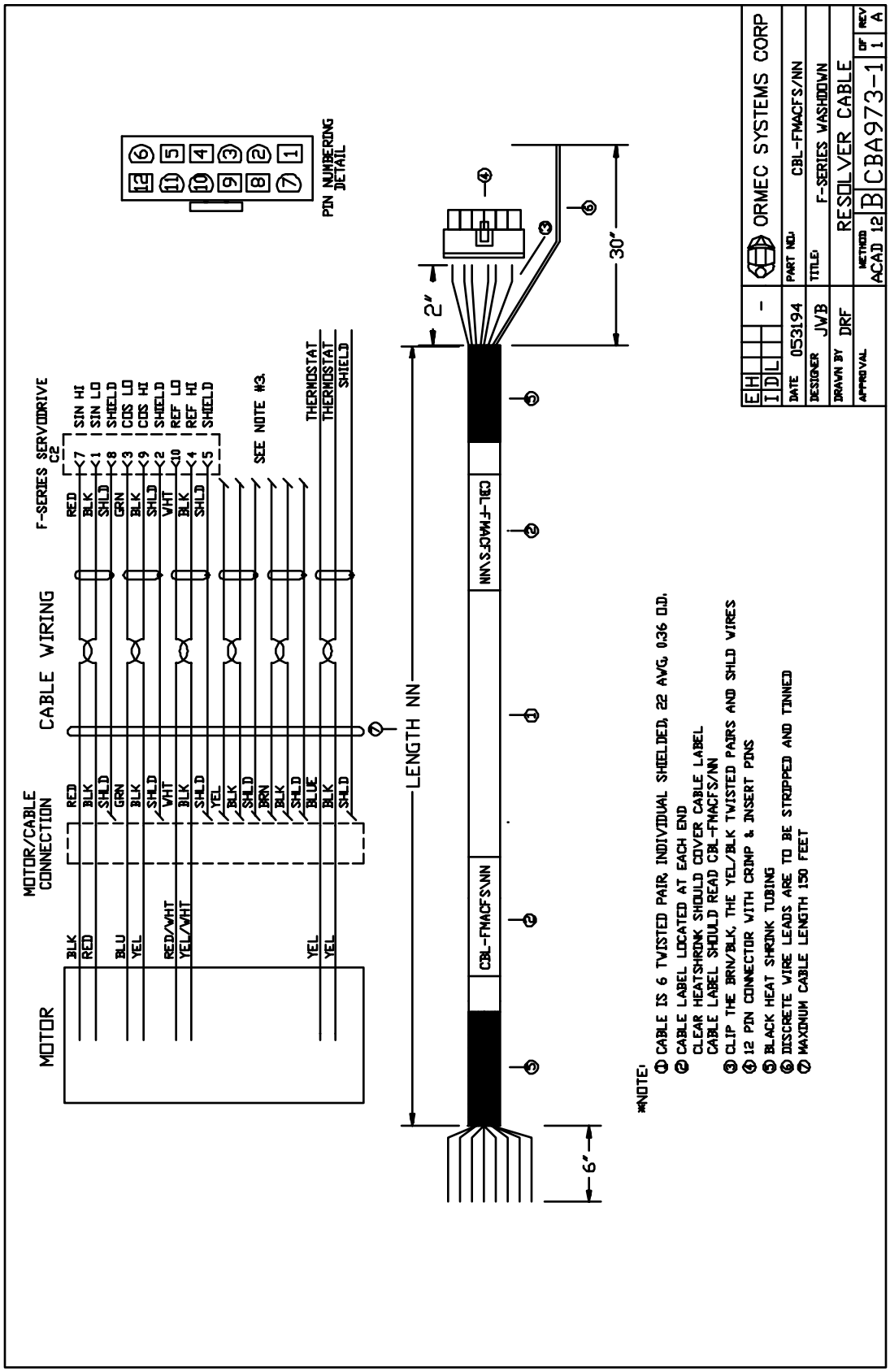
All the installation instructions for F-Series Explosion Proof motors are the same as those for standard F-Series motors, except as noted in this section. Refer to the Servomotor Installation section of the Installation chapter for further information. Also refer to the manufacturers installation and operation manual, supplied with each F-Series Explosion Proof motor, for further information.

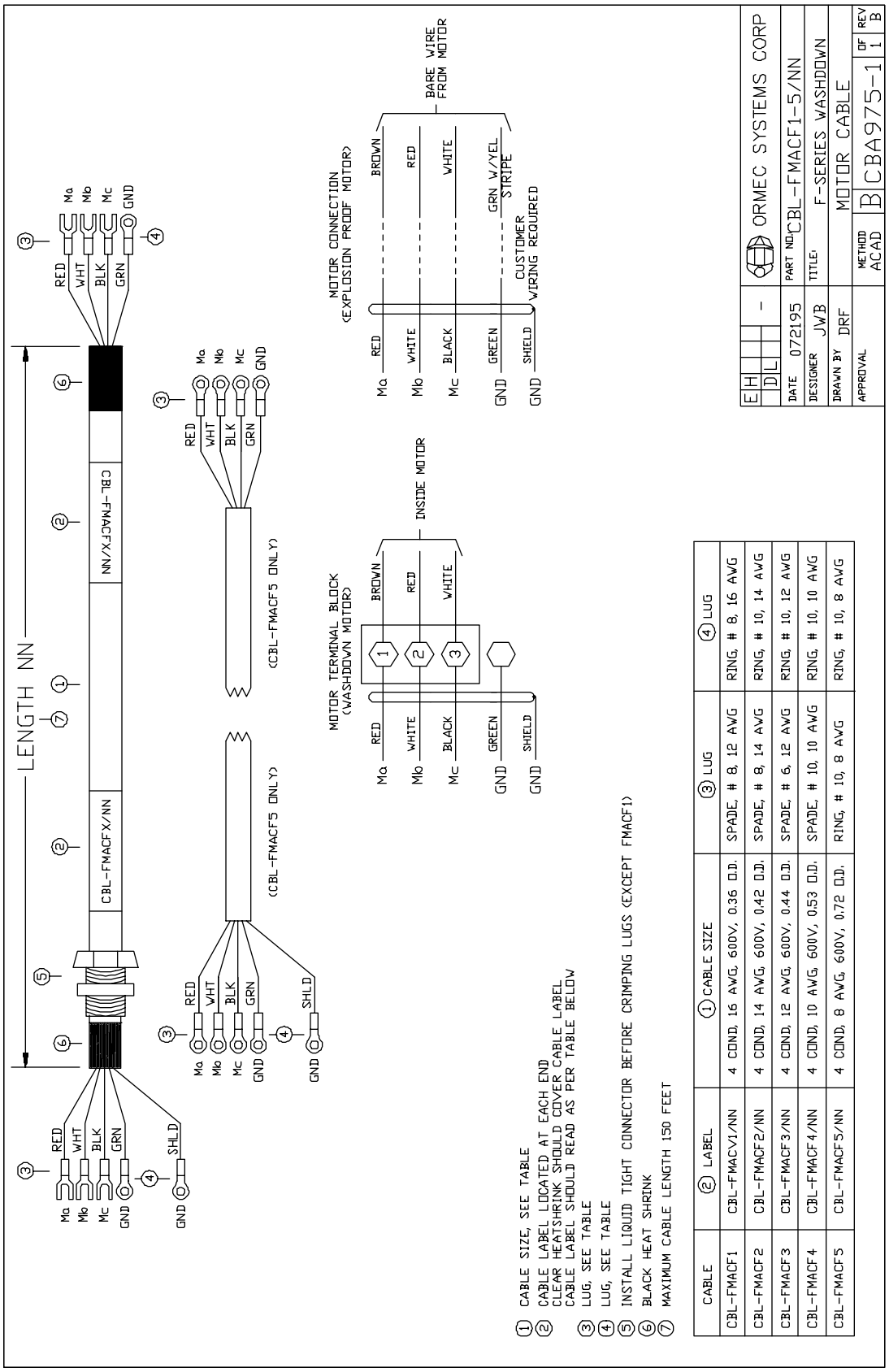
Cable Connections

F-Series Explosion Proof motors are supplied with 2 foot motor and resolver leads exiting the motor through a single NPT fitting provided in the housing. The NPT fitting is intended for attaching explosion proof cable conduit, or explosion proof junction box, directly to the motor.

For a F-Series Explosion Proof motor a CBL-FMACFS/NN is used for the resolver connections. Refer to the CBL-FMACFS/NN drawing included in this Appendix for further resolver cable and installation information.

A CBL-FMACF1-5 is used for the motor connections. This cable is supplied with a liquid tight seal and lugs crimped on the motor end. During installation the lugs and liquid tight seal may be removed if not needed. Attach the motor cable to the motor conductors as indicated on the CBL-FMACF1-5/NN drawing. Refer to the CBL-FMACF1-5/NN drawing included in this Appendix for further motor cable and installation information. NOTE: Explosion Proof motors are not supplied with a terminal strip for the motor power connections, as indicated on the CBL-FMACF1-5 drawing. However, the conductor color codes on the CBL-FMACF1-5 drawing are correct for use with a F-Series Explosion Proof motor.

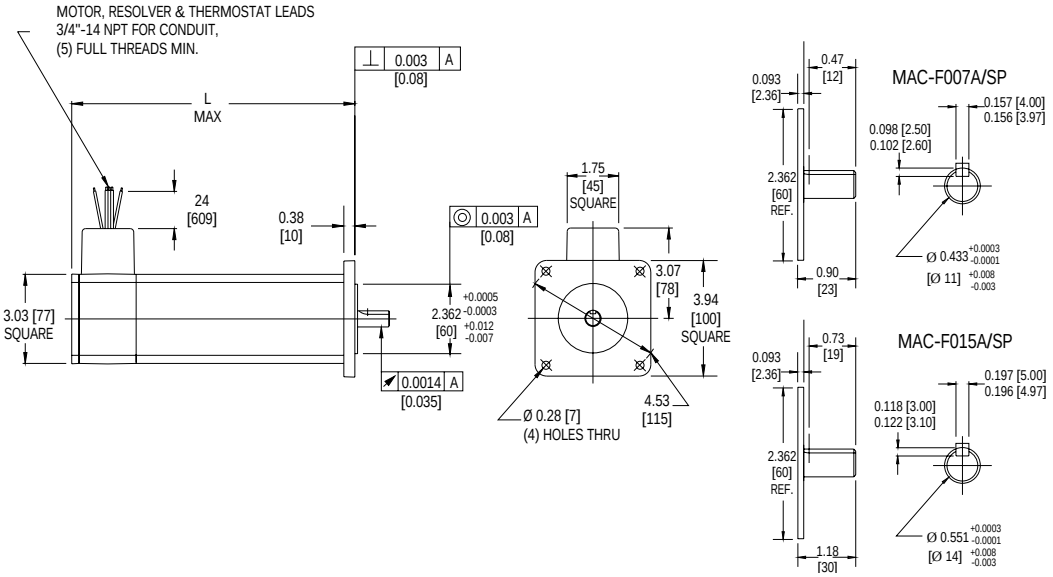

MOTOR
MOTOR/CABLE CONNECTION
CABLE WIRING
F-SERIES SERVODRIVE C2
SIN HI
SIN LO
SHIELD
COS LO
COS HI
SHIELD
REF LO
REF HI
SHIELD
THERMOSTAT
THERMOSTAT
SHIELD
SEE NOTE #3.
LENGTH NN
CBL-FMACFS\NN
2"
30"
6"
PIN NUMBERING DETAIL
NOTE:
1. CABLE IS 6 TWISTED PAIR, INDIVIDUAL SHIELDED, 22 AWG, 0.36 O.D.
2. CABLE LABEL LOCATED AT EACH END
CLEAR HEATSHRINK SHOULD COVER CABLE LABEL.
CABLE LABEL SHOULD READ CBL-FMACFS/NN
3. CLIP THE BRN/BLK, THE YEL/BLK TWISTED PAIRS AND SHLD WIRES
4. 12 PIN CONNECTOR WITH CRIMP & INSERT PINS
5. BLACK HEAT SHRINK TUBING
6. DISCRETE WIRE LEADS ARE TO BE STRIPPED AND TINNED
7. MAXIMUM CABLE LENGTH 150 FEET
ORMEC SYSTEMS CORP
PART NO: CBL-FMACFS/NN
TITLE: F-SERIES WASHDOWN
RESOLVER CABLE
METHOD ACAD 12
B CBA973-1
SIZE B
REV A
DATE 053194
DESIGNER JWB
DRAWN BY DRF
APPROVAL



① CABLE SIZE, SEE TABLE
② CABLE LABEL LOCATED AT EACH END
CLEAR HEATSHRINK SHOULD COVER CABLE LABEL
CABLE LABEL SHOULD READ AS PER TABLE BELOW
③ LUG, SEE TABLE
④ LUG, SEE TABLE
⑤ INSTALL LIQUID TIGHT CONNECTOR BEFORE CRIMPING LUGS (EXCEPT FMACF1)
⑥ BLACK HEAT SHRINK
⑦ MAXIMUM CABLE LENGTH 150 FEET

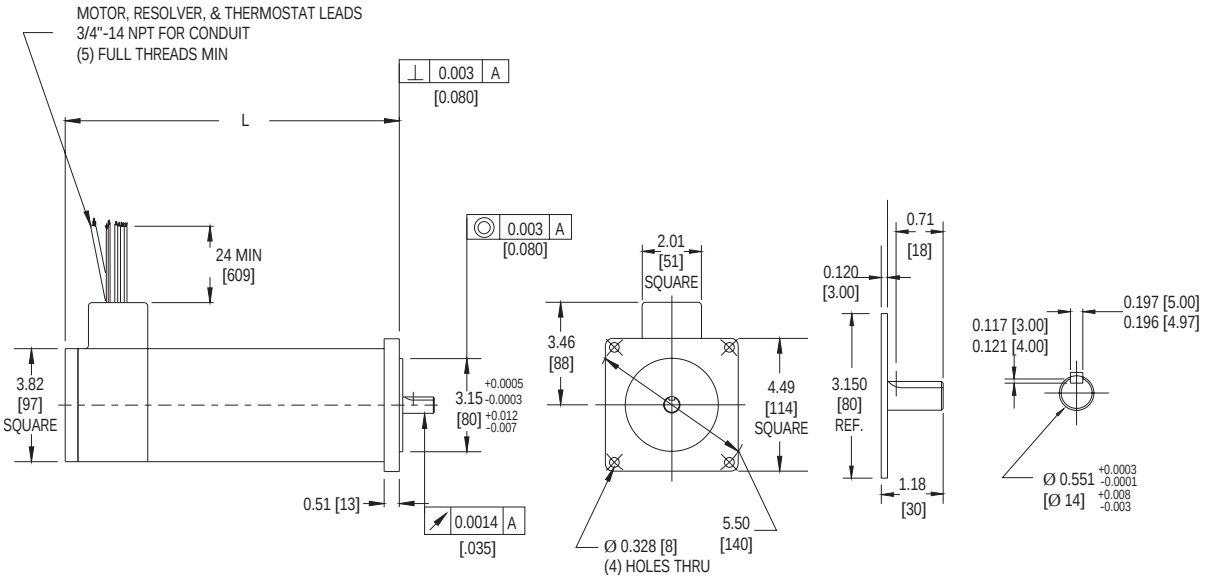
CABLE	② LABEL	① CABLE SIZE	③ LUG	④ LUG
CBL-FMACF1	CBL-FMACV1/NN	4 COND, 16 AWG, 600V, 0.36 O.D.	SPADE, # 8, 12 AWG	RING, # 8, 16 AWG
CBL-FMACF2	CBL-FMACF2/NN	4 COND, 14 AWG, 600V, 0.42 O.D.	SPADE, # 8, 14 AWG	RING, # 10, 14 AWG
CBL-FMACF3	CBL-FMACF3/NN	4 COND, 12 AWG, 600V, 0.44 O.D.	SPADE, # 6, 12 AWG	RING, # 10, 12 AWG
CBL-FMACF4	CBL-FMACF4/NN	4 COND, 10 AWG, 600V, 0.53 O.D.	SPADE, # 10, 10 AWG	RING, # 10, 10 AWG
CBL-FMACF5	CBL-FMACF5/NN	4 COND, 8 AWG, 600V, 0.72 O.D.	RING, # 10, 8 AWG	RING, # 10, 8 AWG

MAC-F007A/SP & F015A/SP Outline Drawing



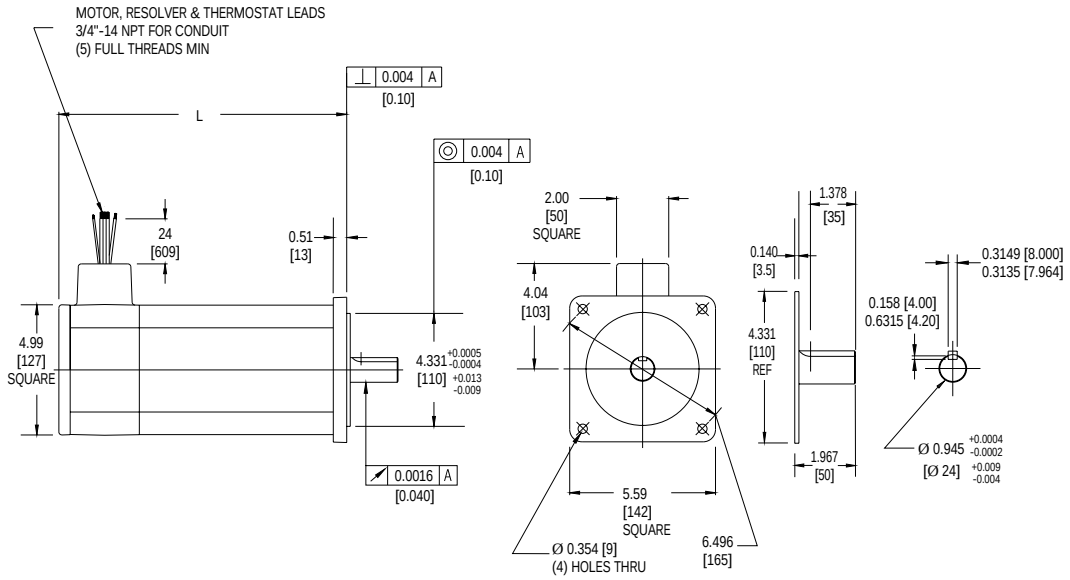
Motor	L	Weight	Thermal Time Constant
MAC-F007A/SP	8.8 [224]	18.5 [8.4]	2 minutes
MAC-F015A/SP	10.0 [255]	27.5 [12.5]	3 minutes

MAC-F020A/SP & F040A/SP Outline Drawing



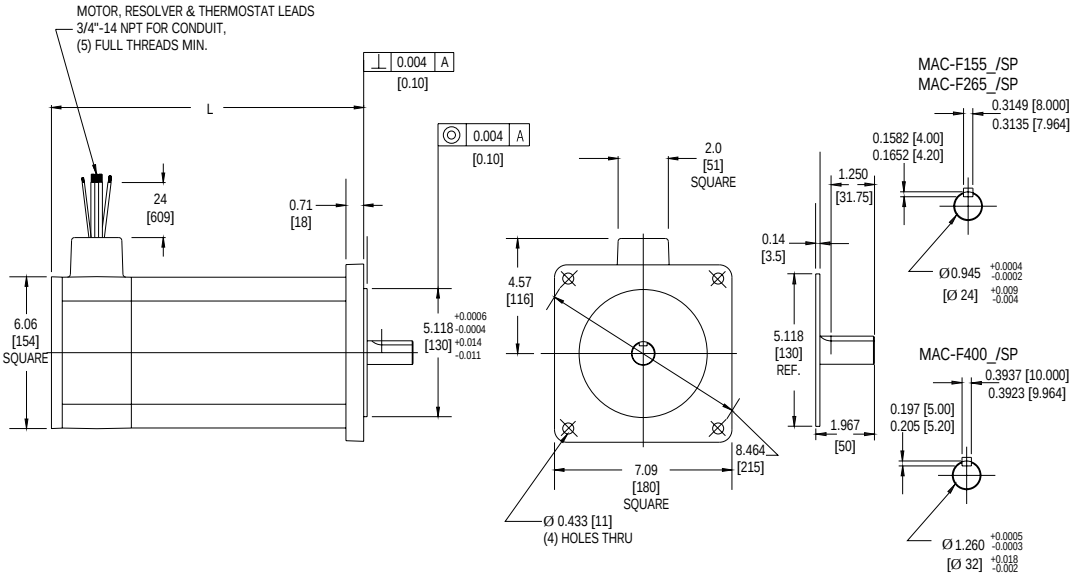
Motor	L	Weight	Thermal Time Constant
MAC-F020A/SP	9.8 [248]	15.0 [6.8]	18 minutes
MAC-F040A/SP	11.3 [288]	18.0 [8.2]	20 minutes

MAC-F060_/SP & F115_/SP Outline Drawing



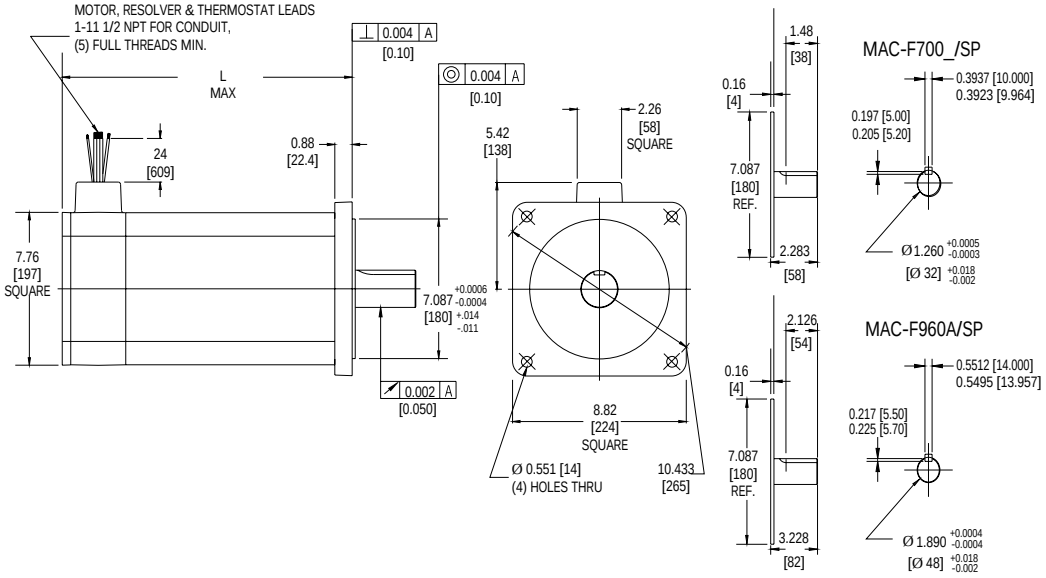
Motor	L	Weight	Thermal Time Constant
MAC-F060_/SP	11.0 [279]	18.5 [8.4]	6 minutes
MAC-F115_/SP	13.1 [333]	27.5 [12.5]	9 minutes

MAC-F155_/SP, F265_/SP, & F400_/SP Outline Drawing



Motor	L	Weight	Thermal Time Constant
MAC-F155_/SP	12.9 [328]	37.0 [16.8]	12 minutes
MAC-F265_/SP	15.6 [396]	51.0 [23.1]	14 minutes
MAC-F400_/SP	18.3 [465]	66.0 [29.9]	16 minutes

MAC-F700_/SP & F960A/SP Outline Drawing



Motor	L	Weight	Thermal Time Constant
MAC-F700_/SP	18.7 [474]	112.0 [50.6]	0.7 minutes
MAC-F960A/SP	22.2 [563]	147.0 [67.0]	0.8 minutes

Appendix G
Brake Motors

Brake Motors

F-Series servomotors are available with optional integral fail-safe brakes. A "B" in the motor options field indicates that the motor is equipped with a brake. Refer to the part numbers below as examples:

MAC-F060A/S**B**

MAC-F155A/S**B**

Specifications

All the specifications for F-Series motors without brakes apply to the corresponding F-Series motors with brakes, except as noted in this section. Refer to the MAC-F Series Servomotors Specifications section of the Specifications chapter for further information.

Standard Housing Motor Specifications (MAC-F____/SB)

Motor	Total Motor Length[1] (inches) [mm]	Total Motor Weight (lbs) [kg]	Total Moment of Inertia (lb-in-sec^{2}x10^{-3}) [kg-m^{2}x10^{-4}]
MAC-F007A/SB	8.8 [222]	6.5 [2.9]	0.296 [0.334]
MAC-F015A/SB	10.0 [253]	8.0 [3.6]	0.430 [0.486]
MAC-F020A/SB	10.1 [256]	10.5 [4.8]	0.901 [1.02]
MAC-F040A/SB	11.7 [296]	15.1 [6.8]	1.55 [1.75]
MAC-F060_/SB	11.6 [294]	21.3 [9.7]	3.38 [3.82]
MAC-F115_/SB	13.7 [347]	29.0 [13.2]	6.33 [7.15]
MAC-F155_/SB	12.9 [328]	43.8 [19.9]	10.2 [11.5]
MAC-F265_/SB	15.6 [396]	57.8 [26.2]	19.1 [21.6]
MAC-F400_/SB	18.3 [465]	72.8 [33.0]	28.0 [31.6]
MAC-F700_/SB	19.3 [488]	118.8 [53.9]	75.5 [85.3]
MAC-F960A/SB	22.8 [578]	153.8 [69.8]	112.7 [127]

[1] This is the total motor length including brake and corresponds to the "L" dimension on the Catalog Motor Outline Drawings. The integral brake is the added to the rear-end of the motor, and does not change any of the other motor dimensions.

Installation

All the installation instructions for F-Series motors without brakes apply to the corresponding F-Series motors with brakes, except as noted in this section. Refer to the Servomotor Installation section of the Installation chapter for further information.

Resolver Cable Connection

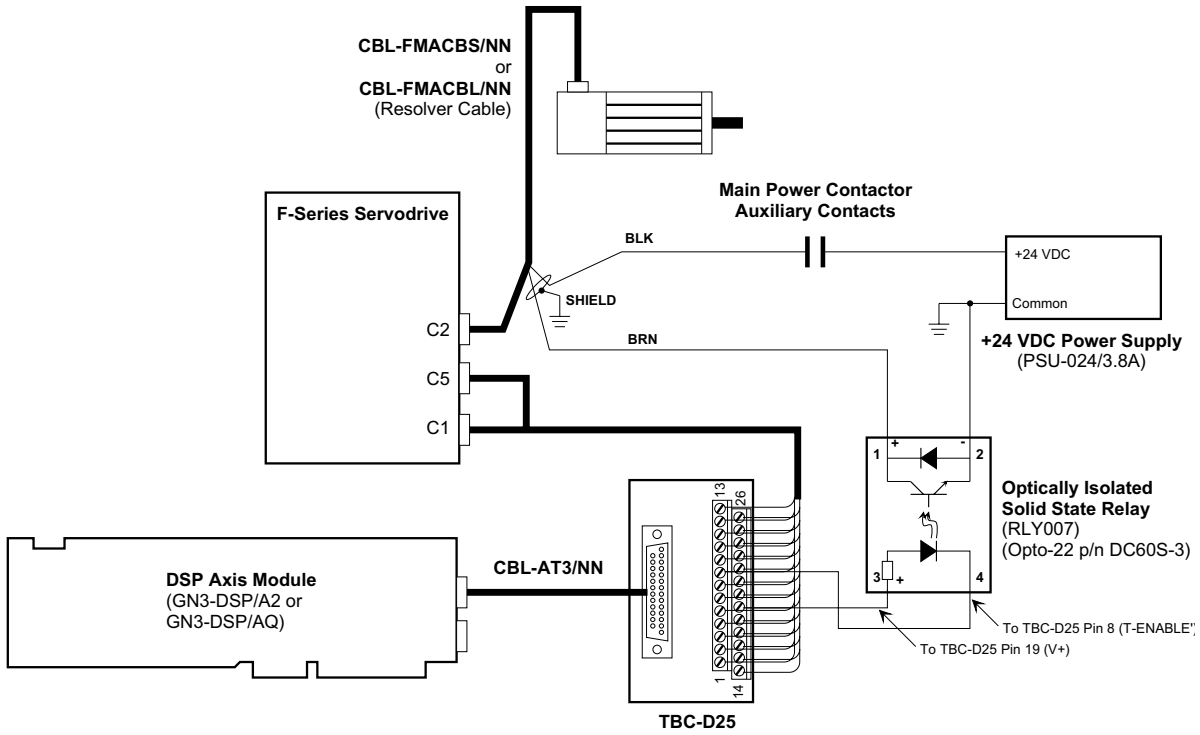
For the MAC-F007A/SB through MAC-F040A/SB motors a CBL-FMACBS/NN is used for the resolver connections, for the MAC-F060A/SB through MAC-F960A/SB a CBL-FMACBL/NN is used. Two additional conductors are supplied in each of these cables for supplying brake coil power. Refer to the CBL-FMACBS/NN and CBL-FMACBL/NN drawings included in this Appendix for further cable and installation information.

System Wiring

Refer to the following diagram for the recommended safety and fault interlock wiring for an F-Series motor with brake. The primary features of this interlock implementation are:

- If the Main Power is disabled by the Main Power Contactor the brake coil power is disabled and the brake engages.
- If the Servodrive is disabled (i.e. the T-ENABLE' signal is unasserted) the brake coil power is disabled and the brake engages.

- If both the Main Power and the Servodrive are enabled the brake coil power is enabled and the brake is disengaged.
- Requires use of a CBL-AFT Axis Interface to Terminal Block cable and a TBC-25 Terminal Block for access to the T-ENABLE' signal from the DSP Axis Module to the Servodrive, and an optically isolated solid state relay to control the brake coil power. **Note: The T-ENABLE' signal is a +10 VDC signal.**
- **DO NOT USE THE MODEL 20/40 POWER SUPPLY FOR COIL POWER!!!**. The Model 20/40 Power Supply should not be used for switching inductive loads such as a relay coil, a separate 24VDC power supply must be used.

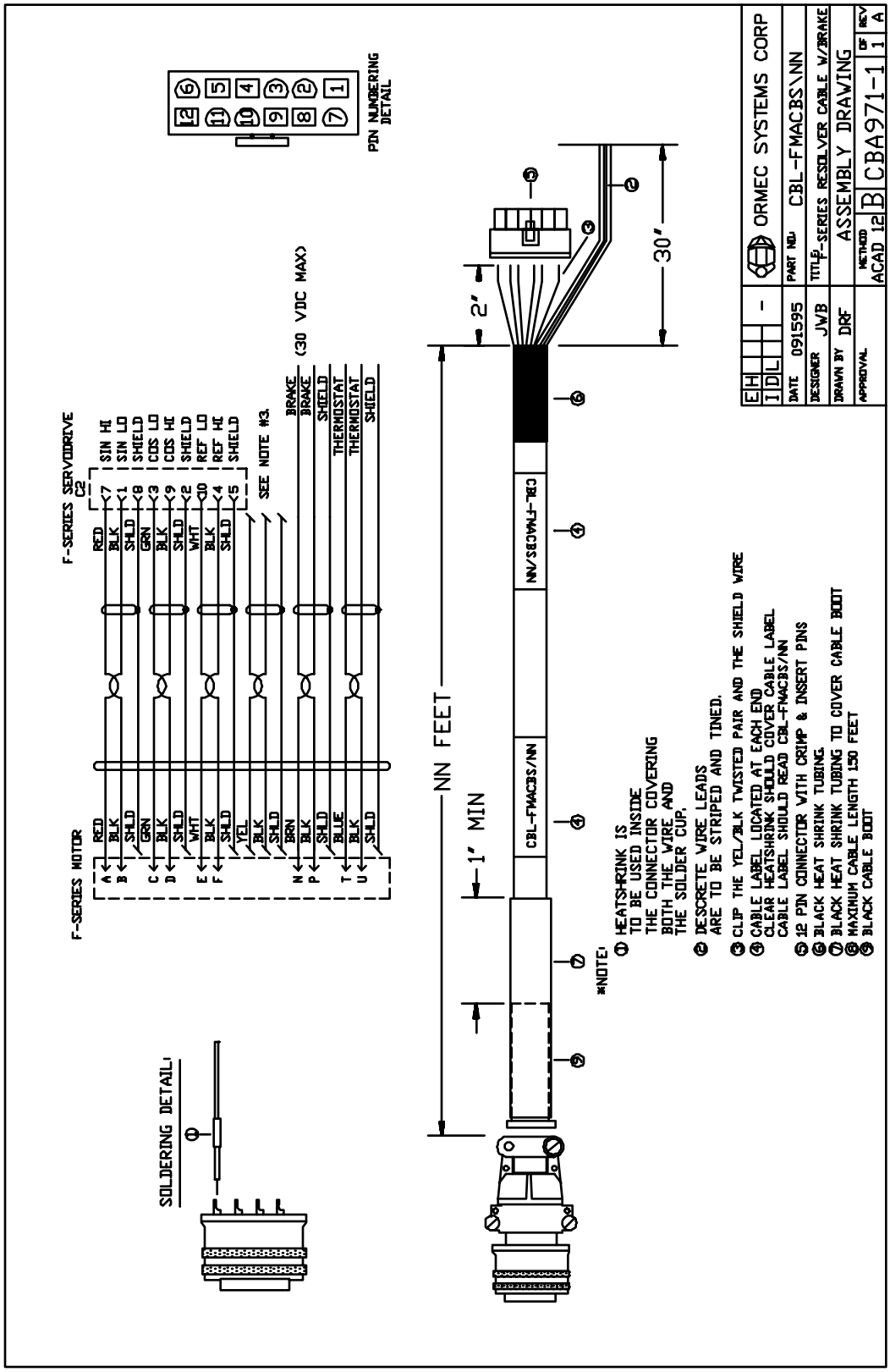


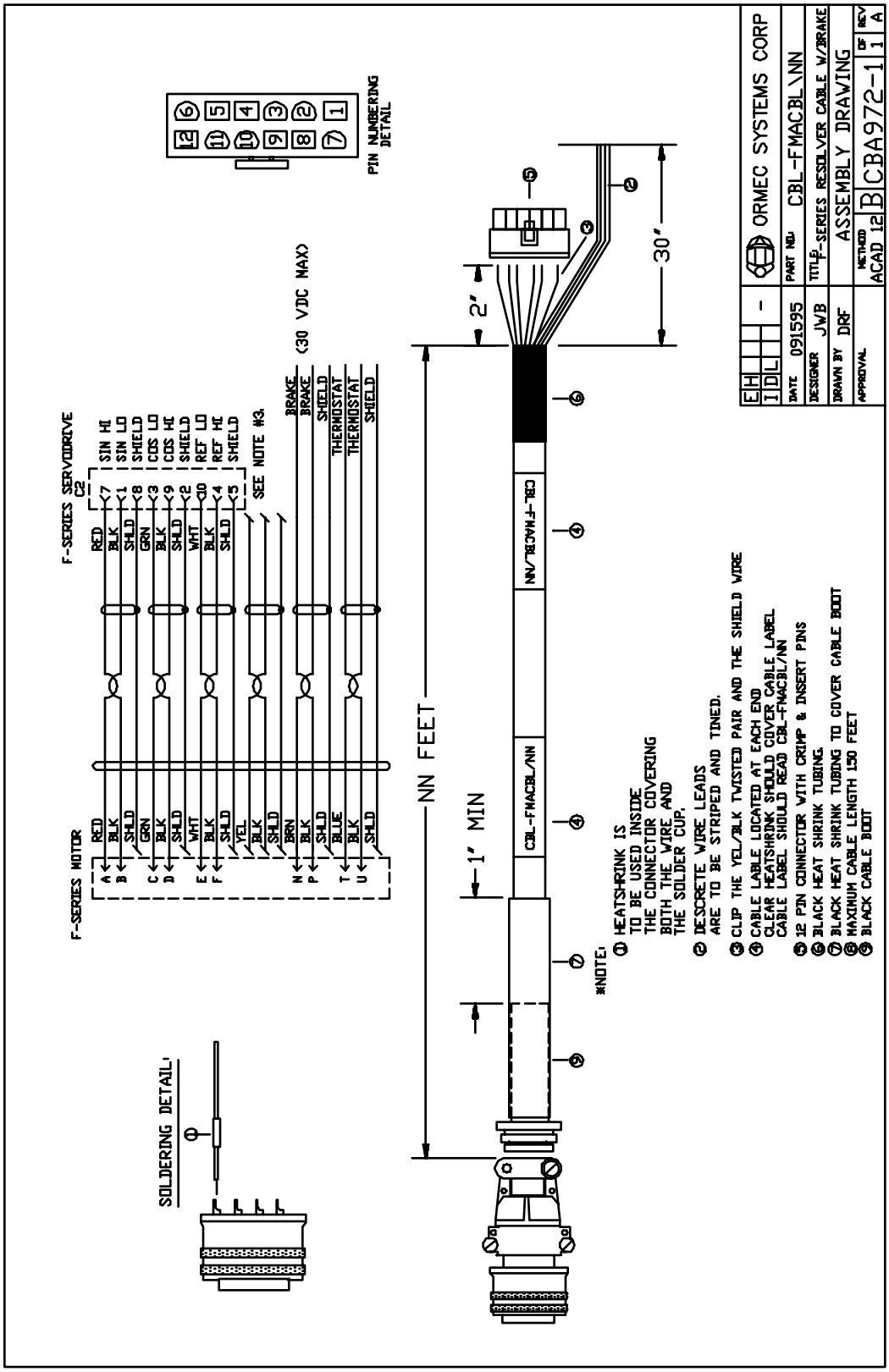
Operation

The following table provides specifications for the motor brakes. The Engage Time specification is the time delay between disabling of the brake coil power and application of braking force. The Disengage Time is the time delay between enabling of the brake coil power and release of the brake. These delays may need to be taken into account in certain applications, the fail-safe barke is a "holding" barke and is not intended to aid in load deceleration.

Motor	**Holding Torque** (lb-in) [N-m]	**Coil Power**[1]	**Engage Time** (coil power disabled) (msec)	**Disengage Time** (coil power enabled) (msec)
MAC-F007A/_B	20.4 [2.3]	24V / 0.57A	100	200
MAC-F015A/_B	20.4 [2.3]	24V / 0.57A	100	200
MAC-F020A/_B	52.8 [6.0]	24V / 1.27A	100	250
MAC-F040A/_B	52.8 [6.0]	24V / 1.27A	100	250
MAC-F060_/_B	72.0 [8.0]	24V / 0.93A	100	250
MAC-F115_/_B	72.0 [8.0]	24V / 0.93A	100	250
MAC-F155_/_B	420 [48]	24V / 1.27A	100	250
MAC-F265_/_B	420 [48]	24V / 1.27A	100	250
MAC-F400_/_B	420 [48]	24V / 1.27A	100	250
MAC-F700_/_B	420 [48]	24V / 1.27A	100	250
MAC-F960A/_B	420 [48]	24V / 1.27A	100	250

[1] The minimum brake coil "pull-in" voltage is 16 VDC.


F-SERIES MOTOR
F-SERIES SERVODRIVE
C2
SEE NOTE #3.
(30 VDC MAX)
BRAKE
BRAKE
SHIELD
THERMOSTAT
THERMOSTAT
SHIELD
SIN HI
SIN LO
SHIELD
COS LO
COS HI
SHIELD
REF LO
REF HI
SHIELD
PIN NUMBERING DETAIL
SOLDERING DETAIL
NN FEET
1" MIN
2"
30"
CBL-FMACBS/NN
*NOTE:
1 HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
2 DESCRETE WIRE LEADS ARE TO BE STRIPED AND TINED.
3 CLIP THE YEL/BLK TWISTED PAIR AND THE SHIELD WIRE
4 CABLE LABEL LOCATED AT EACH END CLEAR HEATSHRINK SHOULD COVER CABLE LABEL CABLE LABEL SHOULD READ CBL-FMACBS/NN
5 12 PIN CONNECTOR WITH CRIMP & INSERT PINS
6 BLACK HEAT SHRINK TUBING.
7 BLACK HEAT SHRINK TUBING TO COVER CABLE BOOT
8 MAXIMUM CABLE LENGTH 150 FEET
9 BLACK CABLE BOOT
ORMEC SYSTEMS CORP
PART NO: CBL-FMACBS\NN
TITLE: F-SERIES RESOLVER CABLE W/BRAKE
ASSEMBLY DRAWING
METHOD: ACAD 12
B CBA971-1
DATE 091595
DESIGNER JWB
DRAWN BY DRF
APPROVAL
REV A
SHT 1


F-SERIES MOTOR
F-SERIES SERVODRIVE C2
RED
BLK
SHLD
GRN
WHT
YEL
BRN
BLUE
SIN HI
SIN LO
SHIELD
COS LO
COS HI
REF LO
REF HI
SEE NOTE #3.
BRAKE
THERMOSTAT
(30 VDC MAX)
PIN NUMBERING DETAIL
SOLDERING DETAIL
NN FEET
1" MIN
2"
30"
CBL-FMACBL/NN
*NOTE:
1. HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
2. DESCRETE WIRE LEADS ARE TO BE STRIPED AND TINED.
3. CLIP THE YEL/BLK TWISTED PAIR AND THE SHIELD WIRE
4. CABLE LABLE LOCATED AT EACH END CLEAR HEATSHRINK SHOULD COVER CABLE LABEL CABLE LABEL SHOULD READ CBL-FMACBL/NN
5. 12 PIN CONNECTOR WITH CRIMP & INSERT PINS
6. BLACK HEAT SHRINK TUBING.
7. BLACK HEAT SHRINK TUBING TO COVER CABLE BOOT
8. MAXIMUM CABLE LENGTH 150 FEET
9. BLACK CABLE BOOT
ORMEC SYSTEMS CORP
PART NO. CBL-FMACBL\NN
TITLE F-SERIES RESOLVER CABLE W/BRAKE
ASSEMBLY DRAWING
METHOD ACAD 12
CBA972-1
SHT 1 OF 1
REV A
DATE 091595
DESIGNER JWB
DRAWN BY DRF
APPROVAL